ENGINEERING DEPARTMENT.

TWENTY-FIFTH ANNUAL REPORT

OF THE

CITY ENGINEER,

BOSTON,

FOR THE YEAR 1891.

Printed for the Department.

BOSTON:
ROCKWELL AND CHURCHILL, CITY PRINTERS.
1892.

With Compliments of

William Jackson,

City Engineer.

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Engineering Department, City Hall,
Boston, Feb. 1, 1892.

Hon. Nathan Matthews, Jr.,
Mayor of the City of Boston:

Sir: In compliance with the Revised Ordinances the following report of the expenses and operations of the department for the year 1891 is respectfully submitted:

The report of this department may be classified under the following heads:

A. — The examination and supervision of structural repairs of bridges, the designing and superintending the construction of new bridges, retaining-walls, city wharves, etc., and in miscellaneous engineering work called for by the City Council.

B. — Charge of the engineering work in connection with the Sudbury-river, Cochituate, and Mystic Water-Works, including charge of new constructions for these works.

C. — Charge of the construction of a system of intercepting and outlet sewers.

D. — Charge of the engineering work in connection with the parks.

E. — Charge of the engineering work, except for Sewer Division, in connection with the Street Department.

The expenses incurred under the head "C" are paid wholly from a special appropriation.

A.

The following is a statement of engineering expenses from January 1, 1891, to January 31, 1892:

Amount expended from department appropriation for 1890–91	$9,633 69
Amount expended from department appropriation for 1891–92	26,989 69
Total	$36,623 38

STATEMENT OF EXPENDITURES, DEPARTMENT APPROPRIATIONS.

OBJECT OF EXPENDITURES.	1891. January to May 1.	1891. May to January 31.	Total Expenditures, Jan. 1, 1891, to Jan. 31, 1892.
Salaries of City Engineer, assistants, draughtsmen, transitmen, levellers, rodmen, etc.	$8,547 06	$24,465 22	$33,012 28
Engineering instruments and repairs of same	72 10	914 74	986 84
Drawing-paper, and all materials for making plans	105 16	306 45	411 61
Stationery, printing-stock, note-books, postage, etc.	164 10	222 22	386 32
Printing	146 19	99 40	245 59
Reference library, binding books, and photographs of works	134 20	170 25	304 45
Travelling expenses (including horse-keeping, repairs on vehicles, etc.)	202 55	476 84	679 39
Telephone service	60 20	144 35	204 55
Furniture cases for plans and books, etc.	.....	30 00	30 00
Blue-process printing	151 25	2 50	153 75
Incidental expenses, and all other small supplies	50 88	157 72	208 60
Totals	$9,633 69	$26,989 69	$36,623 38

CHARLES-RIVER BRIDGES.

Appropriation $15,400 00

Statement of Expenses from Jan. 1, 1891, to Jan. 31, 1892.

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
Cambridge-st. bridge, A. McInnis, contractor, for widening draw-opening	$1,125 00	$941 27	$2,066 27
Essex-st. bridge, W. A. Kenrick & Son, contractors, for widening draw-opening	.....	3,500 00	3,500 00
North Harvard-st. bridge, John Cavanagh & Co., contractors, for widening draw-opening	1,106 72	.....	1,106 72
Western-ave. bridge, Wm. Miller, contractor, for widening draw-opening	.....	3,714 00	3,714 00
Inspection	376 00	.....	376 00
Printing and stationery	34 54	.....	34 54
Lumber	14 35	.....	14 35
Ironwork	42 75	.....	42 75
Totals	$2,699 36	$8,155 27	$10,854 63

Appropriation		$15,400 00
Expended previous to Jan. 1, 1891	$3,383 19	
Expended from Jan. 1, 1891, to Jan. 31, 1892 . . .	10,854 63	
		14,237 82
Balance Feb. 1, 1892 . .		$1,162 18

FEDERAL-STREET BRIDGE.

Appropriation $100,000 00

Statement of Expenses from Jan. 1, 1891, to Jan. 31, 1892.

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
Anti-friction rolls	$340 00	.....	$340 00
Carpenter work, pulling piles, etc.,	73 00	$527 16	600 16
Dynamometer	36 00	.....	36 00
Engineering and inspection	939 58	991 75	1,931 33
Electric machinery	.....	3,871 69	3,871 69
Freight and coal	35 85	.....	35 85
Ironwork and hardware	346 36	989 19	1,335 55
Machinery for draws	.....	1,843 17	1,843 17
Pig-lead for counterbalance, and labor on same	1,543 46	1,258 77	2,802 23
Rent of hoisting-engine	230 00	427 50	657 50
Sidewalk and paving	150 00	112 39	262 39
Snatch-blocks, casks, and rope	105 23	40 42	145 65
Travelling expenses and postage	11 89	5 82	17 71
Shaw & Miller, contractors for rebuilding	7,418 80	42,232 77	49,651 57
Pittsburg Bridge Co., contractors for iron draws	4,266 33	6,086 80	10,353 13
Charles Carr, contractor steel trucks	2,744 00	.....	2,744 00
Totals	$18,240 50	$58,387 43	$76,627 93

Appropriation . . .		$100,000 00
Expended previous to Jan. 1, 1891	$22,657 24	
Expended from Jan. 1, 1891, to Jan. 31, 1892 . . .	76,627 93	
		99,285 17
Balance Feb. 1, 1892 . .		$714 83

FERDINAND–STREET BRIDGE.

Appropriation $35,000 00

Statement of Expenses from Jan. 1, 1891, to Jan. 31, 1892.

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
Advertising	$28 38		$28 38
Engineering and inspection		$575 00	575 00
Printing and stationery	58 12		58 12
Travelling expenses	18 88	6 30	25 18
Parapet stone		20 00	20 00
Parapet and coping-stone, south abutment		198 00	198 00
Cutting, coping, and building fence		350 00	350 00
Teaming		18 00	18 00
R. F. Hawkins, contractor, iron bridge		4,096 45	4,096 45
R. D. Shanahan, contractor, retaining-wall		4,321 33	4,321 33
Street department		5,890 77	5,890 77
Totals	$105 38	$15,475 85	$15,581 23

Appropriation		$35,000 00
Expended previous to Jan. 1, 1891,	$43 80	
Expended from Jan. 1, 1891, to Jan. 31, 1892	15,581 23	
Transferred to Harvard bridge, June 2, 1891	10,000 00	
Transferred to Milton bridge, Oct. 1, 1891	2,500 00	
Transferred to West Newton street, paving, Oct. 5, 1891 . .	5,000 00	
		33,125 03
Balance Feb. 1, 1892 . .		$1,874 97

IMPROVED SEWERAGE.

Total appropriations $5,913,164 93

Statement of Expenses, Improved Sewerage, Jan. 1, 1891, to Jan. 31, 1892.

OBJECT OF EXPENDITURE.	Jan. 1, 1891, to May 1, 1891.	May 1, 1891, to Jan. 31, 1892.	Total Expended, Jan. 1, 1891, to Jan. 31, 1892.
General Office expenses	$3,916 20	$9,813 56	$13,729 76
Moon Island.....	990 75	.....	990 75
Pumping-station	180 00	.....	180 00
" outside	985 00	.....	985 00
Sec. 1, Brighton, Int. Sewer.....	3 00	3,514 78	3,517 78
" 3, Dorchester, " "	1,532 98	.....	1,532 98
" 4, " " "	2,075 83	1,369 84	3,445 67
" 5, " " "	2,548 29	.....	2,548 29
" 6, " " "	142 17	72 08	214 25
" 7, " " "	.....	39 19	39 19
" 8, " " "	.....	14,209 42	14,209 42
" 9, " " "	.....	39 20	39 20
" 10, " " "	12,402 66	28,565 60	40,968 26
" 5, 6, East side, " "	26,190 79	26,650 66	52,841 45
" 3, Outfall Sewer.....	1,018 15	55,441 89	56,460 04
" 7, South Boston, Int. Sewer..	383 89	.....	383 89
" 8, " " " " ..	150 00	23 72	173 72
" 9, " " " " ..	150 00	.....	150 00
Totals	$52,669 71	$139,739 94	$192,409 65

Appropriations		$5,913,164 93
Expended previous to Jan. 1, 1891. . . .	$5,672,836 76	
Expended from Jan. 1, 1891, to Jan. 31, 1892 .	192,409 65	
		5,865,246 41
Balance Feb. 1, 1892		$47,918 52

BRIDGES.

The inspection of the highway bridges for the annual report of their safety and completeness has been made, and, as usual, besides the highway bridges, all such bridges as the Public Garden foot-bridge and the bridges in the Parks have also been inspected.

During the year twelve notifications have been received that bridges have been stripped preparatory to repairing the same, and when notified examinations have been made, plans furnished, and supervision of repairs made when necessary.

Federal-street bridge, which was being rebuilt when the last annual report was made, has been completed.

List of Bridges Inspected.

In the list those marked with an * are over navigable water, and are each provided with a draw.

I. — Bridges wholly supported by Boston.

Agassiz road, in Back Bay Fens.

Ashland street, Ward 23, over Providence Division Old Colony Railroad.

Athens street, over New York & New England Railroad.

Beacon Entrance, Back Bay Fens, over Boston & Albany Railroad.

Beacon street, over outlet to Back Bay Fens.

Beacon street, over Boston & Albany Railroad.

Berkeley street, over Boston & Albany Railroad.

Berkeley street, over Providence Division Old Colony Railroad.

Blakemore street, over Providence Division Old Colony Railroad, Ward 23.

Bolton street, over New York & New England Railroad.

Boylston street, in Back Bay Fens.

Boylston street, over Boston & Albany Railroad.

*Broadway, over Fort Point Channel.

Broadway, over Boston & Albany Railroad.

Brookline avenue, over Boston & Albany Railroad.

Byron street, over Boston, Revere Beach, & Lynn Railroad.

*Charles River, from Boston to Charlestown.

*Chelsea (south), over South Channel, Mystic river.

*Chelsea street, from East Boston to Chelsea.

Columbus avenue, over Boston & Albany Railroad.

*Commercial Point, or Tenean, Ward 24.

Commonwealth avenue, in Back Bay Fens.
*Congress street, over Fort Point Channel.
Cottage-street foot-bridge, over Flats, East Boston.
Cornwall street, over Stony Brook, Ward 23.
Dartmouth street, over Boston & Albany and Providence Division Old Colony Railroad.
*Dover street, over Fort Point Channel.
*Federal street, over Fort Point Channel.
Fen, Back Bay Fens.
Ferdinand street, over Boston & Albany Railroad.
Franklin-street foot-bridge, over Boston & Albany Railroad.
Gold street, over New York & New England Railroad.
Huntington avenue, over Boston & Albany Railroad.
Irvington street, over Providence Division, Old Colony Railroad.
Leyden street, over Boston, Revere Beach, & Lynn Railroad.
Linden Park street, over Stony brook.
*Malden, from Charlestown to Everett.
*Meridian street, from East Boston to Chelsea.
*Mt. Washington avenue, over Fort Point Channel.
Neptune road, over Boston, Revere Beach, & Lynn Railroad.
Newton street, over Providence Division Old Colony Railroad.
Public Garden foot-bridge.
Shawmut avenue, over Boston & Albany Railroad.
Stony brook, Back Bay Fens.
Swett street, east of New York & New England Railroad.
Swett street, west of New York & New England Railroad.
*Warren, from Boston to Charlestown.
West Chester park, over Boston & Albany Railroad.
West Chester park, over Providence Division Old Colony Railroad.
West Rutland square foot-bridge, over Providence Division Old Colony Railroad.
Winthrop, from Breed's Island to Winthrop.

II. — Bridges of which Boston supports the Part within its Limits.

*Cambridge street, from Brighton to Cambridge.
Central avenue, from Ward 24 to Milton.
*Chelsea (north), from Charlestown to Chelsea.
*Essex street, from Ward 25 (Brookline) to Cambridge.
*Granite, from Dorchester, Ward 24, to Milton.

Longwood avenue, from Ward 22 to Brookline.
Mattapan, from Ward 24 to Milton.
Milton, from Ward 24 to Milton.
*Neponset, from Ward 24 to Quincy.
*North Beacon street, from Brighton to Watertown.
*North Harvard street, from Brighton to Cambridge.
Spring street, from West Roxbury to Dedham.
*Western avenue, from Brighton to Cambridge.
*Western avenue, from Brighton to Watertown.

III. — BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

Albany street, over Boston & Albany Railroad.
*Canal, from Boston to Cambridge.
Dorchester street, over Old Colony Railroad.
*Harvard, from Boston to Cambridge.
*Prison Point, from Charlestown to Cambridge.
*West Boston, from Boston to Cambridge.

IV. — BRIDGES SUPPORTED BY RAILROAD CORPORATIONS.

1st. — Boston & Albany Railroad.

Commonwealth avenue, Brighton.
Harrison avenue.
Market street, Brighton.
Tremont street.
Washington street.

2d. — Boston & Maine Railroad, Western Division.

Mystic avenue.
Main street.

3d. — Boston & Maine Railroad, Eastern Division.

Mystic avenue.
Main street.

4th. — Boston, Revere Beach, & Lynn Railroad.

Everett street.

5th. — New York & New England Railroad.

Broadway.
Dorchester avenue.
Fifth street.
Forest Hills avenue, Ward 24.

Fourth street.
Harvard street, Ward 24.
Norfolk " " "
Norfolk " " "
Second street.
Silver street.
Sixth street.
Third street.
Washington street, Ward 24.

6th. — Old Colony Railroad.

Adams street.
Ashmont street and Dorchester avenue.
Cedar Grove Cemetery.
Commercial street.
Savin Hill avenue.

7th. — Old Colony Railroad, Providence Division.

Beech street, Ward 23.
Bellevue street, Ward 23.
Canterbury street, Ward 23.
Centre street, or Hog Bridge, Ward 23.
Centre and Mt. Vernon streets, Ward 23.
Dudley avenue, Ward 23.
Park street, Ward 23.

Recapitulation.

I.	Number wholly supported by Boston	51
II.	Number of which Boston supports the part within its limits	14
III.	Number of which Boston pays a part of the cost of maintenance	6
IV.	Number supported by railroad corporations:	
1.	Boston & Albany	5
2.	Boston & Maine, Western Division	2
3.	" " Eastern Division	2
4.	Boston, Revere Beach, & Lynn	1
5.	New York & New England	13
6.	Old Colony	5
7.	" " Providence Division	7
	Total number	106

Four bridges have been added to the list this year, namely:

Cornwall street, over Stony brook, Ward 23; Irvington street foot-bridge, over the Providence Division of the Old Colony Railroad, and two bridges in the Back Bay Fens, viz., the Fen bridge, and the Stony-brook bridge over the new outlet to Stony brook.

I. — BRIDGES WHOLLY SUPPORTED BY BOSTON.

Agassiz-road Bridge in Back Bay Fens.

This bridge was built in 1887, of brick and stone masonry. It is maintained by the Park Department, and is in good condition.

Ashland-street Bridge (over Providence Division Old Colony Railroad, Ward 23).

The present structure is of iron, and was built in 1875. The ironwork and fences should be painted; otherwise it is in good condition.

Athens-street Bridge (over New York & New England Railroad).

This is an iron bridge, and was built in 1874. The ironwork is badly rusted and is in bad condition. The recommendation of last year is renewed, "that the ironwork be stripped and painted."

Beacon-entrance Bridge (in Back Bay Fens, over Boston & Albany Railroad).

This is an iron bridge, and was built in 1881–82.

It is maintained by the Park Department, and is in good condition. It has been painted.

Beacon-street Bridee (over Outlet of Back Bay).

This is an iron bridge, built in 1880–81. The ironwork should be painted, otherwise the bridge is in good condition.

Beacon-street Bridge (over Boston & Albany Railroad).

This is an iron bridge; it was built in 1884–85; it was widened in 1887–88, and the central roadway was widened a few feet for the accommodation of the cars of the West End Street Railway Co., at the expense of that corporation.

The bridge is in good condition.

Berkeley-street Bridge (over Boston & Albany Railroad).

In process of rebuilding. (See page 90.)

Berkeley-street Bridge (over Providence Division Old Colony Railroad).

The spans over the main track have not been stripped since 1879. At that time the iron beams were found to be somewhat wasted by rust, and intermediate wooden beams were added.

So far as can be seen the wooden beams are in good condition, but it is recommended that this part of the bridge be stripped so that it may be more carefully examined.

The remainder of the bridge is in fair condition.

A movement has been made toward replacing a portion of the bridge by longer spans in order to make both the highway and the railroad more safe, and also to better accommodate the railroad.

Blakemore-street Bridge (over Providence Division Old Colony Railroad).

This is an iron bridge. It was built in 1881–82. It is in good condition.

Bolton-street Bridge (over New York & New England Railroad).

This is a new wooden bridge. It is in good condition.

Boylston-street Arch Bridge (in Back Bay Fens).

The small cracks in the masonry and parapet which have existed since the bridge was built, still open slightly after pointing. They have no significance except as an indication that the whole area around the bridge still continues to settle at a slow rate. The bridge is in good condition.

Boylston-street Bridge (over Boston & Albany Railroad).

This is an iron bridge. It was built in 1886–88.

An ornamental railing, extending over the adjoining retaining-walls should be provided in place of the present temporary fence.

No repairs have been needed, and the bridge is in good condition.

* BROADWAY BRIDGE (OVER FORT POINT CHANNEL).

This is an iron bridge. It was built in 1869–71, and the draw and its foundation were rebuilt in 1874–75.

The floor-beams on the 100-ft. span are crooked and out of plumb; they were originally weak, and appear to be even worse than they actually are.

The main trusses over Foundry and Lehigh streets are out of plumb, and are weak. Estimates have been made for renewing the 100-ft. span, and the spans over Foundry and Lehigh streets, and for strengthening the column sections of the bridge so as to make the structure strong enough to carry the long electric cars now used by the West End Street Railway Co.

The sidewalks are in poor condition; the concrete should be repaired, and the under floor patched where necessary.

The draw-pier is in good condition, so far as it can be seen, but it has not been examined by a diver to ascertain the amount of damage done by Limnoria. The examination of two years ago showed extensive damage already done, and further examination should be made next summer.

BROADWAY BRIDGE (OVER BOSTON & ALBANY RAILROAD).

This bridge is of iron, and was built in 1880–81.

The ironwork is very rusty.

The bridge should be stripped of woodwork, cleaned, and painted.

BROOKLINE–AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD.)

This bridge is of iron, and was built in 1884. It is in good condition.

BYRON–STREET BRIDGE (OVER BOSTON, REVERE BEACH, & LYNN RAILROAD).

This is a wooden bridge. It was built in 1889. It is in good condition.

* CHARLES–RIVER BRIDGE (FROM BOSTON TO CHARLESTOWN).

This is a wooden pile bridge with an iron draw. The original bridge was built in 1785–86; the present structure was built in 1854–55; the draw was built in 1870.

The down-stream pier is in bad condition; the lower end has been forced out of place from one to two feet, and yields

as much more when struck by vessels. The fender-guard is in a ruinous condition.

The sag in the bridge toward the east is more considerable than heretofore, and unless the cross-bracing before recommended is soon applied, it will become dangerous. Several buildings belonging to private parties and attached to the bridge are in precarious condition for lack of suitable foundation.

The floor timbers of the draw are in bad condition. A picket fence has been built in place of the old rails on the draw, to prevent persons from going under the draw; an unidentified tramp having been killed by so doing.

Estimates have been made for rebuilding the bridge.

* CHELSEA BRIDGE, SOUTH (OVER SOUTH CHANNEL, MYSTIC RIVER).

This is a pile bridge with an iron draw. The original bridge was built in 1802–3, and the present structure in 1876–77.

Apparatus has been provided for moving the draw by steam.

The bridge needs a few ordinary repairs, but is in good condition as a whole.

* CHELSEA-STREET BRIDGE (FROM EAST BOSTON TO CHELSEA.)

This is a wooden pile bridge; was originally built in 1834; was rebuilt in 1848, and again rebuilt in 1873, and the present draw was built in 1868.

The part of the bridge between the draw and Chelsea was burned in 1887, and rebuilt in a temporary manner, and the draw is so low that it will be necessary to raise the grade of the whole bridge when a new draw is built.

Estimates for rebuilding this bridge was made in 1889. It is narrow and inconvenient, and the draw and its foundation are in a dangerous condition. The travel over the bridge is increasing, and the passage of vessels through the draw is increasing. It is a dangerous bridge, and its rebuilding should not be delayed.

COLUMBUS-AVENUE BRIDGE (OVER BOSTON & ALBANY RAILROAD).

This is an iron bridge, was originally built in 1865, and the present structure was built in 1876–77.

The bridge is in good condition, except that it is made a

point of attachment for telephone pole guys, and one truss has its upper chord thrown out of line by the strain. The guys should not be allowed to remain.

* COMMERCIAL-POINT, OR TENEAN, BRIDGE (WARD 24).

This is a wooden pile bridge, with a wooden leaf draw. It was originally built in 1833, and the present structure was built in 1875.

This bridge requires repairs, and probably some of the main beams of the draws will have to be renewed next season.

COMMONWEALTH-AVENUE BRIDGE (IN BACK BAY FENS).

This is an iron bridge, and it was built in 1881–82. The ironwork needs painting; otherwise it is in good condition.

* CONGRESS-STREET BRIDGE (OVER FORT POINT CHANNEL).

This is a wooden pile bridge with an iron turn-table draw on a stone masonry foundation. It was built in 1874–75. The fenders are in bad condition, and the heads of exposed spur shores are in some cases rotten. The floor of the main bridge has been patched, and requires more repairs of the same kind. The surface of the sidewalks should be renewed and the under floor patched. A long piece of the sidewalk was removed for the construction of a building on the south side at the city end of the bridge.

A defective main pile was discovered and reported, and the kyanized spruce covering plank on the draw-pier is commencing to decay.

CORNWALL-STREET BRIDGE (OVER STONY BROOK, WARD 23).

This small wooden bridge was built this year. (See page 91.)

COTTAGE-STREET FOOT-BRIDGE (OVER FLATS, EAST BOSTON).

This is a new wooden pile bridge, built in 1889 for foot travel only. It is in good condition.

DARTMOUTH-STREET BRIDGE (OVER BOSTON & ALBANY AND PROVIDENCE DIVISION OLD COLONY RAILROAD).

This is an iron bridge; it was built of wood in 1869, and the present structure was built in 1878–79. It is in good condition.

* Dover-street Bridge (over Fort Point Channel).

This is a wooden pile bridge with a double iron draw; it was originally built in 1805, was rebuilt in 1858–59, and the present structure was built in 1876. The concrete sidewalk is in poor condition. A considerable part of it should be relaid, and the woodwork beneath it repaired. The main floor of the roadway should be carefully examined by removing portions of the paving. It is known to be more or less decayed.

The channel was partially widened several years since to a width of 36 feet, but the work was never completed, and now, at about the level of low water, it is less than that width (which is the legal width of the draw-opening for the bridge). The track timber of the draw and the fender-guard have been repaired.

*Federal-street (over Fort Point Channel).

This bridge was originally built in 1827–28; was rebuilt in 1857–58, was again rebuilt in 1872–73, and the present structure, which is a wooden pile bridge with a double iron draw, was built during the past two years. It is in good condition. (See page 33.)

Fen Bridge (Back Bay Fens).

This new bridge is nearly finished, and can soon be opened to travel.

Ferdinand-street (over Boston & Albany Railroad).

This is an iron bridge. It was originally built in 1864–65, and was strengthened in 1877. The old structure has been removed and replaced by a new bridge. It is in good condition. (See page 35.)

Franklin-street Foot-bridge (over Boston & Albany Railroad).

This is an iron bridge, and was built in 1883. New wooden treads for the stairs are needed, and the bridge should be painted.

Gold-street Foot-bridge (over New York and New England Railroad).

This is a wooden foot-bridge built in 1890.
This bridge is in good condition.

Huntington-avenue Bridge (over Boston & Albany Railroad).

This is an iron bridge. It was built in 1872, and the abutments were rebuilt in 1876–77.

The wing-walls of the abutments should be pointed. The bridge is in good condition, but its surface should be regulated so as to conform to a proper grade of the approaches.

Irvington-street Foot-bridge (over Providence Division Old Colony Railroad).

This is a new bridge built this year. (See page 91.)

Leyden-street Bridge (over Boston, Revere Beach, & Lynn Railroad).

This is an iron bridge, built in 1889. It needs painting; otherwise it is in good condition.

*Malden Bridge (from Charlestown to Everett).

The original bridge was built in 1787. The present structure was built in 1875, and the draw was built in 1872.

The draw-pier and the face of the water-way through the bridge are in bad condition. The draw is very old for a wooden structure; the wood is decayed in many places, the cross-beam, which carries the weight of both trusses to the centre is weak, and the draw-foundation is in poor condition.

Two bents of piles in the fixed part of the bridge, which rest on an old crib, are settling, and should be repaired in the spring. Estimates have been made for building a new draw.

*Meridian-street Bridge (from East Boston to Chelsea).

This is a wooden pile bridge with a wooden turn-table draw on a pile foundation. The original structure was built in 1856. It was rebuilt soon afterwards; was widened and rebuilt as at present in 1884, excepting the draw, which was built in 1875–76.

The bridge has been painted, and is in good condition.

*Mt. Washington-avenue Bridge (over Fort Point Channel).

This is a wooden pile bridge with an iron draw. It was built in 1854, and was rebuilt in 1870–71.

The turn-table of the draw has been repaired. The deck of the draw newly planked with hard-pine and calked, and the bridge painted. The draw-pier is so low that high tides cover it. The draw-tender's house has been enlarged and refitted. The waterways need replanking in part.

Neptune-road Bridge (over Revere Beach & Lynn Railroad in East Boston).

This is an iron bridge, and it was built in 1887–88.

It is maintained by the Park Department.

It needs painting; otherwise it is in good condition.

Newton-street Bridge (over Providence Division Old Colony Railroad.)

This is an iron bridge, and was built in 1872.

It is in good condition.

Public Garden Foot-bridge.

This is an iron bridge. It was built in 1867, and was thoroughly repaired in 1887.

The floor is worn and needs renewal; otherwise it is in good condition.

Shawmut-avenue Bridge (over Boston & Albany Railroad).

This is an iron bridge, and it was built in 1871.

The electric-wire poles of the West End Street Railway Co. are so placed as to make an unsightly bend in the ornamental parapet. The structure of the bridge is in good condition.

STONY-BROOK BRIDGE (BACK BAY FENS).

This is a new bridge, now in process of construction. (See page 74.)

SWETT-STREET BRIDGES (OVER SOUTH BAY SLUICES).

These are wooden bridges, and were built in 1875.

The easterly bridge is in safe condition, and the repairs recommended on the westerly bridge have been made.

The bulkhead wings to both bridges are in bad condition, but they still continue to serve their purpose.

*WARREN BRIDGE (FROM BOSTON TO CHARLESTOWN).

This is a wooden pile bridge with an iron draw; it was originally built in 1828, and the present structure was built in 1883-84.

The fender-guard has been repaired. The kyanized spruce plank on the draw-pier, laid seven years ago, has commenced to decay, and will require patching.

The concrete sidewalk on the down-stream side of the bridge should be resurfaced. As a whole the bridge is in good condition.

WEST CHESTER PARK BRIDGE (OVER BOSTON & ALBANY RAILROAD).

This is an iron bridge, and was built in 1876.

It is in good condition. The grade of the surface of the bridge and approaches should be improved, as recommended for Huntington-avenue bridge.

WEST CHESTER PARK BRIDGE (OVER PROVIDENCE DIVISION OLD COLONY RAILROAD).

This is an iron bridge, and it was built in 1876.

It is in good condition.

WEST RUTLAND-SQUARE FOOT-BRIDGE (OVER PROVIDENCE DIVISION OLD COLONY RAILROAD).

This is an iron bridge; it was built in 1882, and is in good condition.

It should be painted.

WINTHROP BRIDGE (FROM BREED'S ISLAND TO WINTHROP).

This is a pile bridge without a draw; it was originally built in 1839, was rebuilt in 1851, and was extensively repaired in 1870.

The bridge is old and poor, but is still in a safe condition.

II. — BRIDGES OF WHICH BOSTON SUPPORTS THE PART WITHIN ITS LIMITS.

*Cambridge-street Bridge (from Brighton to Cambridge).

This is a wooden pile bridge with a wooden leaf draw. It was rebuilt in 1884.

The work of widening the passageway for vessels, which was in progress under the supervision of the City Engineer of Cambridge at the date of the last report, has been completed.

The division of the cost between the two cities has not yet been finally adjusted, but the total cost will fall within the appropriation of $15,400 made by the city of Boston for the four bridges over the Charles river; namely, Cambridge street, Western avenue to Cambridge, North Harvard street, and Essex street.

The draw-pier has been lengthened slightly and planked.

The bridge is in good condition.

Central-avenue Bridge (over Neponset River, Dorchester Lower Mills).

This is an iron bridge, and was built in 1876.

It is in good condition.

*Chelsea Bridge, North (from Mystic-river Corporation Wharf to Chelsea).

The original structure was built in 1802–3; the present structure was built in 1880, except the draw, which was built in 1873.

Apparatus has been provided for moving the draw by steam. The fixed part of the bridge is in fair condition. The arrangements for draining the gravel under the paving do not work well, and water continues to drip over the outer stringers for a long time after rain. The draw and draw foundation are in poor condition.

The cluster of piles under the draw pivot should be spliced, and there is much rotten wood in the draw. It should be partially stripped and the defective parts removed.

*Essex-street Bridge (from Brighton to Cambridge).

This is a wooden pile bridge with a wooden leaf draw, and was originally built in 1850.

The work of widening the waterway has been completed, and the draw is in good condition, except that it needs replanking; a new sidewalk has been built.

The bridge as a whole is old and poor and should be rebuilt, as a natural consequence of the widening of Commonwealth avenue, so as to cross the Grand Junction Railroad above grade. (See page 38.)

*GRANITE BRIDGE (FROM WARD 24 TO MILTON).

This bridge was originally built in 1837. It is a wooden pile bridge with a wooden leaf draw.

The draw-piers are not well placed with reference to the course of the river and the direction of the current, consequently great difficulty is found in passing vessels through there, and travel over the bridge is delayed by the long time required to pass vessels of large size.

LONGWOOD-AVENUE BRIDGE (FROM WARD 22 TO BROOKLINE).

The present structure was built in 1877. This is a wooden bridge on wooden posts set in the ground.

The posts which carry the bridge are decaying near the surface of the ground. They should be put in order; otherwise the bridge is in good condition.

MATTAPAN BRIDGE (FROM WARD 24 TO MILTON).

This is an old iron bridge; it is in a dangerous condition. It should be replaced by a stone bridge.

MILTON BRIDGE (FROM WARD 24 TO MILTON).

The original structure is very old; it was widened in 1871–72. The older part of this bridge was built of stone, and the widening is an iron structure on stone columns. The floor of this bridge has been repaired and the fences painted. It is in fair condition.

*NEPONSET BRIDGE (FROM WARD 24 TO QUINCY).

The original structure was built in 1802; the present structure in 1877.

The lower pier has been planked and a new sidewalk built. The bridge is in fair condition. The ironwork should be painted.

*North Beacon-street Bridge (from Brighton to Watertown).

This is a wooden pile bridge with a wooden leaf draw. The original structure was built in 1822, and the present structure in 1884. It is in fair condition.

Estimates have been made for rebuilding and widening the waterways of the bridge, and the next lower one on the river, namely, Western avenue to Watertown, the expense to be divided between Boston and Watertown.

*North Harvard-street Bridge (from Brighton to Cambridge).

This bridge was originally built in 1662, and was rebuilt in 1879.

The work of widening the waterway to 36 feet has been completed, and a new shelter for the draw-tender built. The abutment is in poor condition. (See page 38.)

Spring-street Bridge (from Ward 23 to Dedham).

This is a stone bridge, and it is in good condition, except that the rail on the bridge is too low.

*Western-avenue Bridge (from Brighton to Cambridge).

The original structure was built in 1824; the present structure was built in 1879–80. The waterway has been widened to 36 feet under the supervision of the City Engineer of Cambridge. The pier needs planking. The draw should be adjusted and made to run easier than at present.

*Western-avenue Bridge (from Brighton to Watertown).

This is a wooden pile bridge. It was built in 1824, the present draw was built in 1883, and the abutment was rebuilt in 1886. It is in good condition. As before stated under head of "North Beacon Street bridge," estimates have been made for rebuilding the bridge and widening the passageway for vessels.

III.— BRIDGES OF WHICH BOSTON PAYS A PART OF THE COST OF MAINTENANCE.

Albany-street Bridge (over Boston & Albany Railroad).

The original structure was built in 1856–57; was rebuilt in 1867–68, and again in 1886–87.

It is in good condition.

*Canal Bridge (from Boston to Cambridge).

*Prison-point Bridge (from Charlestown to Cambridge.

*West Boston Bridge (from Boston to Cambridge.)

These bridges are in the care of two commissioners, appointed, one from Boston and one from Cambridge, and the expense of maintenance is borne equally by each city. The commissioner for the city of Boston is the Superintendent of Streets.

West Boston Bridge.

This is a wooden pile bridge with an iron turn-table draw. The bridge was originally built in 1792–93, was rebuilt in 1854, and repaired in 1871. The draw was rebuilt in 1875.

The repairs of the westerly bulkhead, sidewalk, and adjacent roadway, recommended as necessary in the last report, have been made.

Substantially the same plan was adopted as that used in repairing the opposite side of the bridge in 1886. The bridge has been relieved of a large and useless weight of gravel and mud, all decayed timber has been removed, a new sidewalk of hard-pine timber and kyanized spruce plank has been built, and upon it a brick sidewalk, laid in sand, was laid. The old edgestones have been reset, the roadway plank, wherever uncovered, has been protected by a layer of salt mud, and the roadway between the curbstone and street-railroad track has been repaired, using the old paving-blocks.

The part of the bridge repaired as above described includes all the up-stream sidewalk between the draw and the Cambridge abutment, and about one hundred feet in length on the same side of the bridge next the Boston abutment.

Bids were advertised for and the contract was awarded to Josiah Shaw, the lowest bidder.

Total cost, $10,520.50, of which city of Boston paid one-half.

A new boiler for the engine turning the draw has been provided, and the turning apparatus put in good order. The up-stream end of the draw-pier is in bad condition, and will require to be repaired and strengthened. The plank sides of the waterway are in bad condition, and require immediate attention.

The paving of the roadway and sidewalks from the draw to the Boston end, and the bulkheads next the Charles-river embankment, should be repaired. With the exceptions above noted the bridge is in as good condition as it is practicable to put so old and narrow a structure. The need of a new and wider bridge becomes more apparent year by year.

Canal, or Craigie's Bridge.

This is a wooden pile bridge, with a wooden turn-table draw. The bridge was originally built in 1808, was rebuilt in 1852, and again rebuilt and widened in 1874. Some of the piles in this bridge date from 1808.

The foundation to the engine-house on the draw-pier has been put in good condition. A portion of the roadway paving was relaid last year; the remaining surface should be repaired.

The fender on the up-stream side is in bad condition. The hard bottom prevents the driving of piles in the usual manner, and a different plan must be adopted to protect the bridge from vessels. The sides of the waterway need new planking.

The wooden draw shows signs of age, and the piling under the Boston end will soon require attention. The bridge as a whole is in fairly good and safe condition.

Prison-point Bridge.

This bridge was originally built in 1833, and the present structure was built in 1876–77. It is a wooden pile bridge, with an iron leaf draw.

The draw-pier has been replanked, and necessary repairs made to the roadway and machinery for moving the draw.

Dorchester-street Bridge (over Old Colony Railroad).

This is an iron bridge; it was built in 1869.

This bridge is principally supported by the Old Colony Railroad. No repairs have been made upon it. In last

year's report the following statement was made: "The bridge has not been stripped and painted for ten years. It is known to be in bad condition, just how bad cannot be ascertained without removing all the woodwork. It should be thoroughly overhauled in the spring." Nothing has yet been done.

*HARVARD BRIDGE (FROM BOSTON TO CAMBRIDGE).

This bridge is practically completed, and was opened for travel Sept. 1, 1891. It is still in the hands of the commission by which it was built.

The bridge is built across the Charles river, and connects West Chester park, in Boston, with Front street, in Cambridge.

The length of the bridge between centres of bearings on abutments is 2,164 ft. 9 in.; the distance between harbor lines, measured at centre line of bridge, being 2,159 ft. $4\frac{5}{8}$ in.

The bridge is a deck bridge, its width, excepting at and near draw, being 69 ft. 4 in. measured between centre of railings. This width is divided into one roadway 51 ft. wide, and two sidewalks each 9 ft. 2 in. wide.

The draw is 48 ft. 4 in. wide between centres of railings, the width of roadway being 34 ft. 6 in. and the width of each sidewalk 6 ft. 11 in. The elevations of roadway curb on bridge, above Boston city base, are 21 ft. at abutments, and increase to 29.5 ft. at piers 6 and 17, the bridge being level between these two piers.

The requirements to be fulfilled in the design of the bridge were such that only spans of moderate length could be used, and as built, the bridge is composed of fixed and suspended spans, generally 75 ft. $2\frac{1}{2}$ in. long, with piers averaging 90 ft. 3 in. between centre.

The bed of the river at the bridge is generally composed of a deposit of mud and other soft material, overlying clay of varying consistency, excepting near the ends of the bridge, where gravel is found.

The substructure consists of two masonry abutments, twenty-three masonry piers, and one pile foundation and fender-pier for draw-span.

The foundations for the abutments and masonry piers were built on the same general plan. The bottom of the river was excavated by dredging to such depths and over such areas, at and about the proposed foundations, as was thought expedient, in the case of the abutment foundations the dredging being carried to 4 feet below city base, and to

depths varying from 3 ft. to 15 ft. for the pier foundations, the depths being determined by the amount of soft material at the pier.

The Boston abutment, and all piers, excepting Nos. 21, 22, and 23, rest on piles. These piles are sound and straight spruce piles, not less than 6 in. diameter at the point, and of such size at the butt that, when cut off at grade, one-half of them were 10 in. diameter, and the balance not less than 9 in. diameter. All measurements of piles were taken under the bark. The piles under the abutment were driven vertically, but under the piers the outside rows were driven with an inclination of one horizontal to twenty vertical.

All piles were cut off at a point about 2 ft. below city base, a slight variation in the levels of the tops of the piles being allowed. After the piles were driven a sheet-pile curbing was constructed about the space to be occupied by the foundation, the curbing being built with its top at grade 6 ft. above city base, or at about half-way between average high and low tide.

The purpose of this curbing was to form an inexpensive coffer-dam for "half-tide" work, in constructing the concrete base and stonework, and also when partially removed by cutting off at grade .83 ft., to retain the material under and about the piles and to protect the concrete base.

The space enclosed by the sheet-pile curbing was filled with concrete to grade 0, the concrete below grade 1 below city base being deposited around and on top of the piles through large sheet-iron pipes. No dumping of concrete into the water was allowed.

The concrete so deposited formed a water-tight bottom to the curbing or coffer-dam, and the balance, or upper foot in thickness, of the concrete was carefully deposited in place and levelled while the coffer-dam was free from water.

The concrete was made of one part of Portland cement, two parts of sand, and five parts of broken stone or pebbles from $\frac{1}{4}$ in. to $2\frac{1}{2}$ in. in their greatest diameter; all parts by measure.

The concrete foundations of the Cambridge abutment, and of piers 21, 22, and 23, rest directly upon the gravel bottom. The abutment masonry is of granite laid in American cement mortar, made of one part of cement and two parts of sand. The stones in the faces of the abutments are large rectangular blocks, laid in six courses, varying from 21 in. to 24 in. in thickness, the stones in each course being of equal rise. The stones are laid with 1-in. horizontal and vertical face joints. About one-fifth of the face area of the wall is

D. W. BUTTERFIELD, PHOTOGRAPHER, CAMBRIDGE, MASS.

HARVARD BRIDGE.

composed of headers not less than five feet in depth. Face stones are qurrry-faced, full and pitched to line, without drill or dog holes, and with no projections of more than 3 in., and no hollow faces. Backing is of large rubble-stones well bonded to face-stones.

Bridge-seat courses are rough-hammered on top and laid with $\frac{3}{8}$-in. vertical joints and 1-in. horizontal or bed joints. Front of course is quarry-faced, pitched to line. Parapet-courses are rough-hammered on all exposed surfaces, and laid with $\frac{3}{8}$-in. joints throughout.

All face joints in the abutments are pointed with Portland cement mortar for a depth of $2\frac{1}{2}$ in.

The pier masonry is of granite laid in Portland cement mortar, made of one part of cement and two parts of sand.

The thickness of the piers, at bottom, is 6 ft. 9 in., and at top 4 ft. 0 in. to 4 ft. 6 in., according to height of pier. The lower, or foundation, course is made of headers extending the entire thickness of the pier. The beds of this course are dressed to lay not more than 1-in. joints, the builds dressed to lay $\frac{3}{8}$-in. joints, and the vertical joints dressed for $\frac{3}{8}$-in. joints, for one foot from faces of piers, the balance of vertical joints being from 1 in. to $1\frac{1}{2}$ in. wide. The end stones of the foundation-course are of special shape.

The rise of courses in the piers, between the concrete foundation and the coping-course, is as follows: For piers 4 and 19, 2 ft. 3 in.; for all other piers the lower two courses are 2 ft. 3 in., and the remaining courses 2 ft. 0 in. The courses above the bottom or header course are of ashler masonry, laid in "Flemish bond," with special stones and bond at the ends of the piers.

The stretchers are not less than 6 ft. long, excepting at ends of piers, and are not less than 23 in. wide where the piers are 4 ft. thick, and not less than 2 ft. wide where the thickness of the piers exceed 4 ft., the face batter being included in these widths. The end vertical joints for a distance of one foot from face of pier, and the beds and builds, are dressed to lay $\frac{3}{8}$-in. joints; the back is quarry-split. The headers extend through the pier and are not less than 2 ft. wide, and have beds, builds, and one foot of vertical joints, from face of pier, dressed for $\frac{3}{8}$-in. joints. Pier faces of stones are quarry-faced, with no projections of more than 3 in., and no hollow faces; they are pitched to line and batter required. The pointed ends of piers are cut with a $1\frac{1}{2}$-in. chisel draft on each side of pier.

The spaces between the stones of the stretcher-courses are filled with concrete of the same kind as used in the foundation. The coping-course is 2 ft. thick, and is from

4 ft. 9 in. to 5 ft. 3 in. wide, according to width of pier. The stones of these courses are dressed for $\frac{3}{8}$-in. bed and vertical joints, and are rough-hammered full to line on top. Faces are quarry-faced, pitched to line, and show no drill or dog holes.

End stones are dowelled to stones below with $1\frac{1}{4}$-in. iron dowels set in neat cement mortar. The pointed end of this course has $1\frac{1}{2}$-in. chisel draft each side of point. Stone blocks 3 ft. 6 in. by 4 ft. 6 in. and $17\frac{1}{4}$ in. to $24\frac{3}{4}$ in. thick are set on the piers to take shoes of bridge girders. They are dowelled to coping-course with $1\frac{1}{2}$-in. diameter iron dowels set in Portland cement.

The general details of piers are shown in the "Section of Pier 9," on accompanying plate.

The curbing is shown as cut off after the pier was completed, the dotted portion extending to grade 6 ft. above city base, being that used as a coffer-dam for half-tide work. The coffer-dam served the purpose for which they were intended, that of facilitating the depositing and levelling of the upper portion of the concrete foundation, and allowing the stonework to be laid out of water.

On many of the piers the entire foundation-course was laid while the curbing was free from water between half ebb and half flood tide.

The foundation-piles shown are those at the middle of the pier. The number of piles in a pier were 112, excepting for piers 11 and 12, where they were increased in number to 140.

The width of the concrete foundations of piers 11 and 12 was increased to 15 feet.

The foundation of draw is made of oak piles capped with hard-pine timber. The timbers supporting bottom track of draw are 18 in. by 18 in., laid in two courses upon radial timbers 18 in. by 18 in., resting on capping of piles.

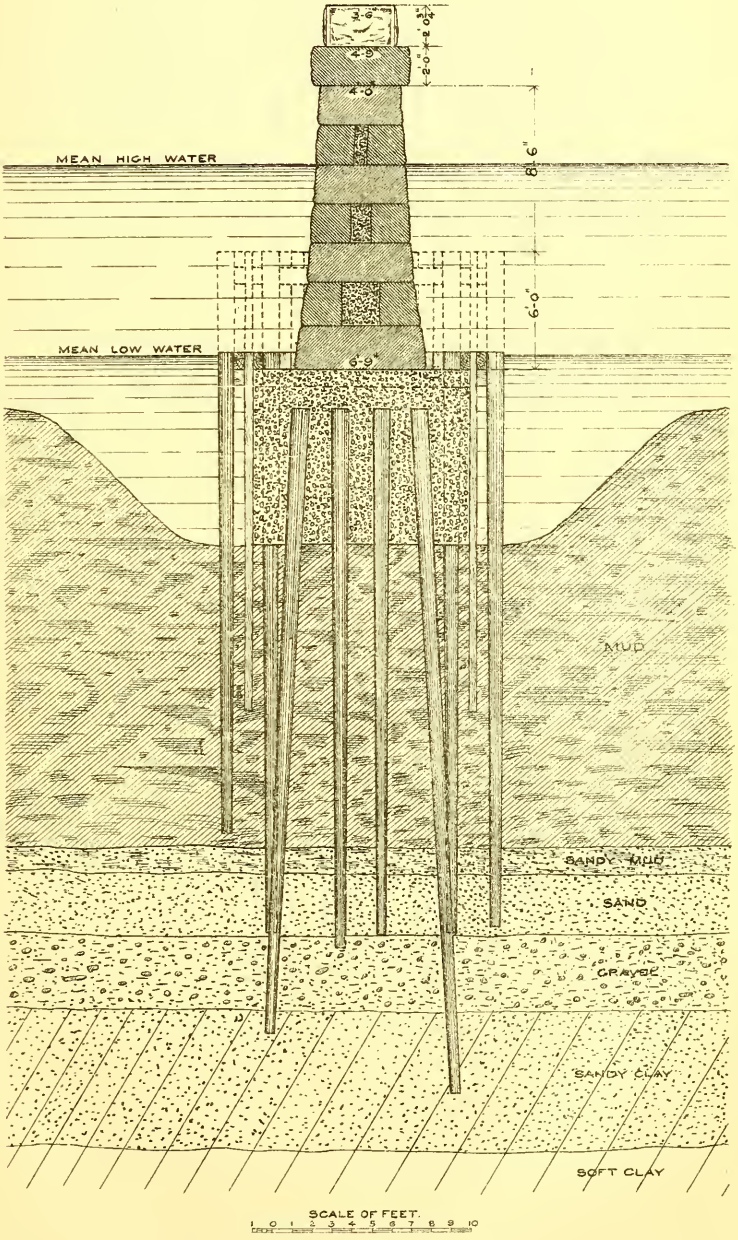
The draw-pier is 56 ft. wide and 356 ft. long, and is made of oak piles, capped and planked. The caps are hard-pine and the planking is 3-in. kyanized spruce. The faces of the pier are planked with 4-in. hard-pine, laid vertically, and fastened with $1\frac{1}{2}$-in. oak treenails.

Oak pile fenders, planked in same manner as faces of draw-pier, are built on channel sides of piers 11 and 12. The width of channels or waterways at draw is 36 ft. plus.

The superstructure consists of 23 fixed spans and one swing draw-span. It is of the cantilever type, the general spans being alternately 75 ft. $2\frac{1}{2}$ in. and 105 ft. $3\frac{1}{2}$ in. between centres of piers. The shorter spans are provided with cantilevers 15 ft. $\frac{1}{2}$ in. long projecting beyond each

HARVARD BRIDGE.

SECTION OF PIER 9.



pier. From these cantilevers a span 75 ft. 2½ in. long is suspended, forming, with the cantilevers, the longer span of 105 ft. 3½ in. The end spans and those next to draw are modifications of this system. The main girders are plate girders, and are in four lines, 17 ft. 4 in. on centres. They are generally 8 ft. deep over piers and 5 ft. deep at mid span, the depth being measured from out to out of flange angle-irons. The general panel length is 15 ft. ½ in. The girders set upon fixed and roller shoes on the piers, connection between girders and shoes being made by pins. The suspended girders are attached to cantilevers by means of pin and link connections, which, with the rollers on the piers, provide for expansion and contraction.

The floor-beams and sidewalk-brackets are plate girders, riveted to the main girders. The lateral bracing systems are made of rods with loop-eyes and sleeve-nuts, and struts of built section where necessary. The sway bracing is of adjustable rods or riveted angle-braces.

The fixed spans of the bridge were erected without false works. Two main girders of each span, together with the floor-beams coming between them, were riveted together, on shore, and transported to position on a scow. By taking advantage of the tide, and by arrangements for increasing or diminishing the draught of the scow, the span was easily placed upon the pier or hung in position between the cantilevers. The draw span-girders are plate girders, two in number, 8 ft. deep over turn-table, 4 ft. deep at ends, and 143 ft. 8 in. long over all. The main girders are placed 35 ft. apart on centres. Floor-beams and sidewalk-brackets are plate girders.

The main girders are connected to two heavy cross girders 6 ft. deep, which rest upon the drum of the turn-table. The turn-table drum is of wrought iron, 33 ft. in diameter and 2 ft. 6 in. deep, fitted with a planed cast-iron track. Wheels are cast iron, 21 in. in diameter, with turned treads 7½ in. wide. Bottom track is of cast iron, planed on both sides.

Roadway and sidewalk stringers are hard-pine, notched to floor-beams and sidewalk-brackets, to give required grade and pitch to sidewalks and roadway.

The under course of roadway plank on fixed spans is 4-in. thick kyanized spruce, and the upper course 2-in. thick spruce, excepting between the street-car tracks where it is 3 in. thick. The roadway is provided with iron scuppers for draining it. Sidewalk plank on fixed spans is 2½ in. thick kyanized spruce.

The wearing surface of the walks is made of asphalt, laid in the following manner: The plank having been covered

with heavy sheathing paper, a layer of gravel and pebbles, or small stone screenings, mixed with coal-tar pitch, was laid, this layer being approximately $\frac{1}{2}$ in. thick; on this a base layer of asphalt $\frac{3}{4}$ in. thick was placed, Barber Trinidad asphalt being used on one-half of the work and Limmer asphalt mastic being used on the other half.

The inner edges of the sidewalk are fitted with an angle-iron guard, and the outer edges are provided with a white-pine facia and galvanized-iron edging. The flooring for the draw-spans is the same as that for the fixed spans, excepting that the sidewalk is covered with 2-in. thick white-pine plank.

The railing posts are cast iron and are connected to special castings fastened to ends of sidewalk-brackets. Every other post extends above the hand-rail and carries a globe for a light. The upper or hand-rail of the railing is made of a $3\frac{1}{2}$-in. diameter boiler-tube and a $1\frac{3}{4}$-in. channel-iron; the lower rail is made of a $2\frac{1}{2}$-in. channel-iron, and the intermediate rail of $1\frac{3}{4}$ in. $\times$ $\frac{5}{8}$ in. bar iron. The vertical rods are $\frac{3}{4}$ in. diameter.

One-half of the lamp-posts on the fixed spans, and all of those on the draw, are provided with incandescent electric lights; the balance of the lamp-posts being fitted with gas-lights.

The power for operating the draw is obtained from a 10-horse power Thomson-Houston electric-motor placed under the roadway and connected to gearing which can also be operated by hand-power. The draw is also provided with a friction-brake for controlling its motion during opening and landing. The motor and brake are operated from a point on the sidewalk of the draw.

Table showing the Number of times the Draw was opened, and the Number of Vessels which passed through Harvard Bridge.

1891.	No. of Openings.	No. of Vessels.
January		11
February	98	100
March	97	110
April	239	269
May	261	380
June	287	381
July	257	362
August	180	253
September	178	258
October	97	139
November	198	285
December	160	203
Totals	2,058	2,751

IV. — BRIDGES SUPPORTED BY RAILROADS.

Washington-street bridge, over the Boston & Albany Railroad, has been partially rebuilt. A new roadway has been provided, and the old roadway girders are only used to carry the sidewalk.

Savin Hill avenue bridge has not yet been rebuilt, but an appropriation has been made by the city for paying the part of the cost of doing so on account of a widening of the street.

The extension of the electric car service of the West End Street Railway Co. has raised questions concerning the strength of many highway bridges maintained by railroad corporations and of the libability of the city, if any. Consequently the Corporation Counsel was requested by the City Council to advise it, and he rendered the following opinion, which is also printed in the City Council Minutes for 1891, page 1157:

City of Boston,
Office of the Corporation Counsel, Nov. 21, 1891.

To the Honorable the Board of Aldermen:

Gentlemen: I am requested to give my opinion as to the powers of the Board of Aldermen as Surveyors of Highways, or County Commissioners, in regard to the matters referred to in a letter of William Jackson, City Engineer, dated Nov. 16, 1891. From reading this letter, and the proceedings of the Board on its receipt, I suppose that your honorable body wish my opinion as to whether the New York & New England Railroad Company can be compelled by the Board of Aldermen to strengthen its bridge on Broadway so as to allow electric cars to be run over it with safety. I am informed that the bridge referred to is one which by law the New York & New England Railroad Company is bound to keep in repair, and that the bridge is in good repair, and strong enough to sustain a weight of twelve or fourteen tons, but not strong enough to sustain the weight of one of the long electric cars now used by the West End Railroad Company, together with the number of passengers that are often carried on such cars.

The theory concerning highways seems to be that they are the property of the people of the Commonwealth, and are under the control of the Legislature, except where the Legislature has delegated authority to some municipality or public body. By law cities and towns are obliged to keep the highways within their limits reasonably safe and convenient, except where other provision is made.

In this case other provision has been made by the Legislature, and the city of Boston and your Board have no power in the matter. In the language of the Supreme Court in Rouse *v.* Somerville, 130 Mass., 363, "By law this bridge and approaches are to be made and kept in repair by the railroad corporation. As a matter of law and of right the city can in no mode interfere with the construction and repair of such approaches otherwise than an individual might." If the New York & New England Railroad Company does not keep its bridge in repair, an information lies in favor of the Attorney-General of the Commonwealth for its neglect so to do, and it is also liable to any traveller who is injured by reason of any defect in such bridge. But as the Legislature has provided that neither towns, cities, nor other persons bound by law to repair ways shall be liable for damages to any person whose

carriage and the load thereon exceed the weight of six tons, I do not think the New York & New England Railroad Company can be compelled by any process of law to strengthen its bridge so as to bear the weight of vehicles which, with their loads, sometimes weigh nearly twenty tons. If a part of the highway is strong enough to sustain the weight of a vehicle weighing more than twice the weight limited by the statutes, I have no doubt that it is reasonably safe and convenient in the meaning of the statute. If your honorable body is informed, or has reason to believe, that any portion of a highway is not strong enough to support the weight of the electric cars in use by the West End Road, and is strong enough to fulfil the statute requirements, your Board ought not to permit the use of such heavy cars upon such highway until the street-railway company has so strengthened such portion of the highway as to make it possible to operate such cars without danger to life.

Respectfully submitted,

(Signed) THOMAS M. BABSON,
Corporation Counsel.

The bridges over the New York & New England Railroad, on Norfolk street, referred to in last year's report, have been slightly repaired. They are poor bridges.

The other bridges in the list of bridges supported are strong enough for ordinary travel, and require no special mention.

MISCELLANEOUS WORK AND CONSTRUCTION IN 1891.

BENNINGTON-STREET CULVERT.

See page 90.

BERKELEY-STREET BRIDGE (OVER BOSTON & ALBANY RAILROAD).

See page 90.

CURBING FOR PUBLIC SQUARES IN EAST BOSTON.

At the request of the Superintendent of Public Grounds, plans and specifications were prepared for granite curbings around Belmont, Central, and Maverick squares, East Boston.

The curbing at Belmont square was furnished by J. Harrington & Son, Somerville, at a cost of $2,998; that at Central square by Austin Ford, Cambridge, at a cost of $3,165, and that at Maverick square by B. F. Nay & Co., at a cost of $1,533.20.

CHELSEA-BRIDGE STEAM POWER.

See page 91.

Chelsea Bridge (North) Fender-guard.

See page 91.

Cornwall-street Bridge.

See page 91.

East Boston Bridge.

In compliance with the following order of the City Council, approved by the Mayor, Sept. 19, 1891,

"That the City Engineer communicate with citizens of East Boston, and, in consultation with them, prepare plans for a bridge to East Boston, and take such measures as he deems proper to assist the Board of Harbor and Land Commissioners in their inquiry as to the expediency of constructing a bridge to East Boston," a plan was devised for a bridge to East Boston.

The proposed bridge was located near the North ferry, and, with its approaches, was about 2,300 feet long, the channel at this point being about 1,450 feet between bulkhead lines. The proposed bridge was an iron structure, supported on piers; it was 80 feet in width with a swing draw 60 feet wide, having two drawways, 100 feet wide, for vessels, the vessel drawways to have a clear height under the draw of 35 feet at mean high water. The roadway of the bridge was to be of granite-block pavement, excepting on the draw, where it was to be of wood.

Federal-street Bridge.

As mentioned in the last annual report, the rebuilding of every part of this bridge, except the two draws, was let to Shaw & Miller, by contract, dated July 23, 1890, for $67,467.

The bridge was rebuilt, one-half at a time, without interruption to travel. The up-stream half of the bridge was closed to travel July 29, 1890; opened to travel Feb. 14, 1891; the down-stream half was closed to travel Feb. 16, and opened Aug. 12, 1891. The up-stream half was again closed Aug. 18, 1891, and the whole bridge was opened to travel Sept. 12, 1891, and the whole work on Shaw & Miller's contract was completed Oct. 16, 1891.

The bridge is 69 feet wide between fences and is built of hard-pine lumber on an oak-pile foundation. There are two sidewalks, each 10 feet wide, covered with asphalt, on a base of coal-tar concrete. The roadway is 49 feet wide, except at the draws, where it is divided into two roadways, each 21 feet in width.

The roadway is covered with 6-inch kyanized spruce lumber; on this is a layer of fine coal-tar concrete, three inches thick, heavily rolled while hot; above this is a granite-block paving laid in a bed of sand, having the joints filled with small pebbles and run with hot paving-cement.

The down-stream pier has been lengthened 58 feet; the drawway has been widened from 36 feet to 41 feet 10 inches, and is now planked with vertical planks extending 2 feet below low water.

The iron draws in the bridge are two in number, and are of the retractile pattern. The channel span of each draw are placed side by side, the draws being drawn to opposite sides of the channel when opened.

Each draw is 32 feet 9 inches wide between centres of main girders, and carries a roadway 21 feet wide in the clear, and a sidewalk 10 feet 3 inches wide from curb to centre of railing.

Each draw is composed of two non-continuous plate girder spans, one of which spans the channel through the bridge, the other, or rear span, being supported on trucks running on tracks built on the draw foundation.

When a draw is closed, and in position for travel over it, the channel span is supported at its front end on shoe-plates on the main bridge, the other end being attached to and supported by the rear span by a pin connection. When the draw is in motion or run off, the front end of the channel span is supported by suspension rods passing over Samson posts on rear span to back end of this span, proper counter-balances being provided where necessary. The counter-balance used on these draws are cast-iron boxes filled with lead.

The motive power for the draws is electricity, in addition to which gearing, etc., is provided for operating them by hand or horse power in case of accident to the electric plant.

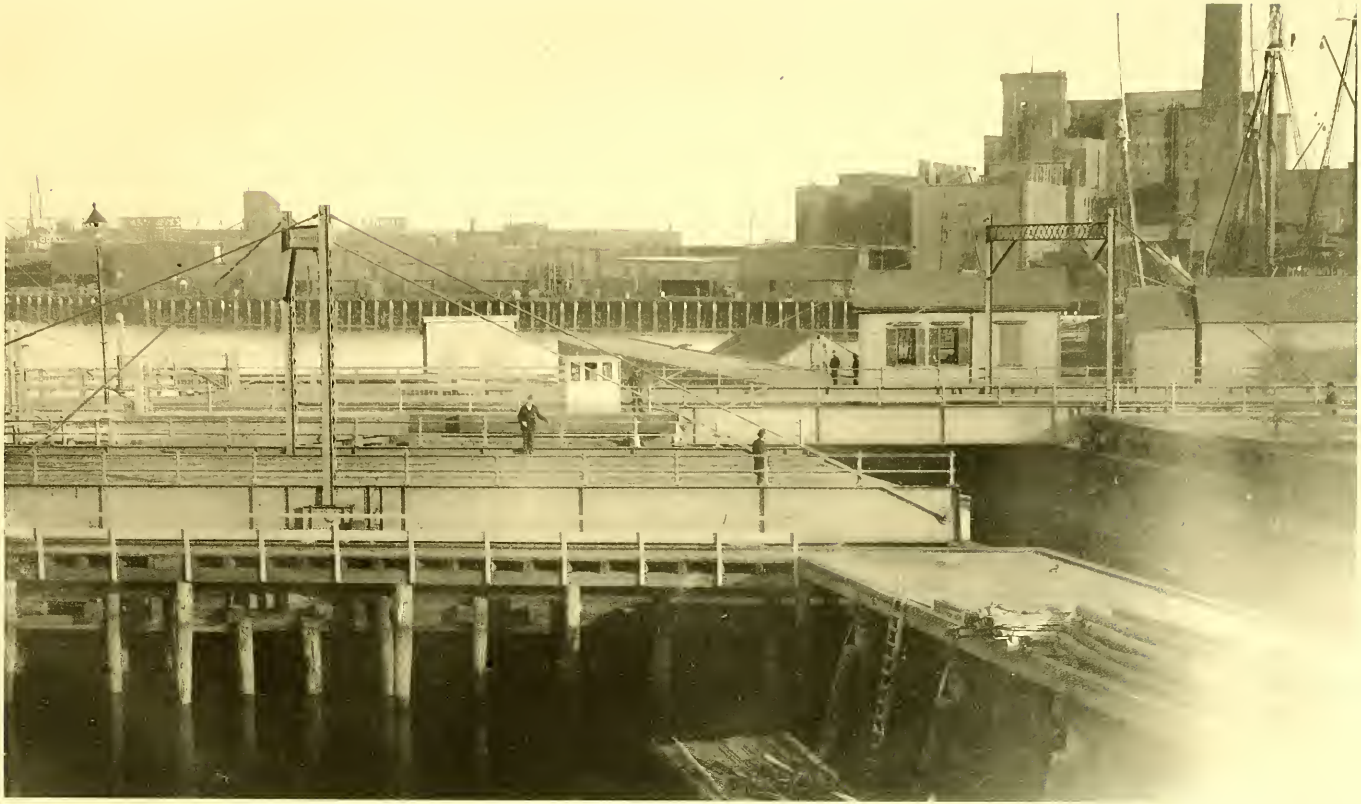
Each draw is moved by a 20-horse power Thomson-Houston motor, connected by shafting to a horizontal drum under the draw, from which drum motion is transmitted to the draw by a wire rope. The general arrangement of drums, etc., is similar to that for the draws at Warren bridge.

The draws are operated and controlled by one man, from a small house situated near the channel, on the Boston side. Thus far the electric power has worked satisfactorily.

The draws and the machinery for operating them were designed by this department.

The contractors for the pile bridge were Shaw & Miller, of Boston.

The draws were built by the Pittsburgh Bridge Co., and



HELIOTYPE PRINTING CO. BOSTON.

FEDERAL STREET DRAWBRIDGE, 1891.

HELIOTYPE PRINTING CO. BOSTON.

FEDERAL STREET DRAWBRIDGE, 1891

the machinery by the Whittier Machine Co., of Boston, and Miller & Shaw, Cambridge.

The electric plant was furnished by the Thomson-Houston Motor Co., Boston.

The total expenditure for the work to Feb. 1 was $99,285.17.

FERDINAND-STREET BRIDGE (OVER THE BOSTON & ALBANY RAILROAD).

In July, 1890, this bridge was closed by order of the Mayor, an examination made by this department having shown that it was unsafe to permit its further use. An appropriation of $35,000 for rebuilding the bridge was made by the City Council and approved by the Mayor, Nov. 12, 1890. Plans and specifications were at once prepared and the work advertised Dec. 10, 1890.

The plan of rebuilding provided for filling solid the portion of the street, north of the railroad track, supported by iron posts, and for building a retaining-wall on the westerly line of the street, about 73 feet long, to hold this filling and to supersede an old timber bulkhead. The only portion remaining to be bridged was that over the track of the Boston & Albany Railroad.

The bridge is a single span of two through-plate girders, 79 feet long, and is 40 feet wide between centres of railings, affording a clear roadway of 22 feet, and two overhanging sidewalks of 7 feet 6 inches each. The two main girders are 6 feet 6 inches deep at the centre, and 5 feet 6 inches deep at the ends, and were designed so that in case the bridge should be widened to 50 feet it would be only necessary to add one new girder and one set of floor-beams, as illustrated in last year's report. The floor-beams and sidewalk brackets are built iron beams and the stringers are of hard-pine. The roadway planking is of spruce, under course 4 inches thick and upper course 2 inches thick. The sidewalk planking is 2 inches hard-pine. The fences are 6 feet high, made of matched white-pine boards. New granite parapets were laid on both abutments, and the coping on the south-east retaining-wall was relaid and brought to the new grade of the street.

As it was desirable to complete the work of rebuilding as speedily as possible, it was deemed best to build the retaining-wall of concrete. The wall as built is supported on a spruce pile foundation with a cap of Portland cement concrete, 4 feet thick and varying in width from 13 feet at the highest part of the wall to 11 feet at the low end. The

body of the wall is built of cement concrete made in the proportions of one part of cement, two parts of sand, and five parts of broken stones, deposited in layers of 8 inches in thickness and thoroughly rammed. With the exception of an upper course, 12 inches thick, the cement used was American hydraulic of approved brand. Portland cement was used for the upper 12-inch course. Extending from the foundation to the coping, a brick facing, 8 inches thick, was built in front of the wall, laid solid in Portland cement mortar and thoroughly bonded to it. Along the entire length of the wall a granite coping, 30 inches wide and 18 inches thick, was laid, and on this was placed a close board fence, 6 feet high, supported by iron standards.

The contractor for the retaining-wall and parapets was R. D. Shanahan, of Portland, Me.; total amount paid, $4,869.23. The contractor for the superstructure was the R. F. Hawkins Iron Works, Springfield, Mass.; amount paid, $4,096.45. The total amount expended by this department from the appropriation, including engineering and inspection, was $9,734.36.

FERRY DEPARTMENT.

The building of a part of the ferry-slip at East Boston, North ferry, by J. N. Hayes & Co., mentioned in the last annual report, was completed Feb. 14, 1891, and the cost of the contract work was $7,480.

An interesting feature of this work was the successful driving of twenty-five very large oak piles, with the small end upward, reversing the usual method. The work of driving these piles was done without difficulty. As these piles are not required to sustain weight, but to resist sidewise thrusts and blows, applied from twenty to thirty feet above hard bottom, they are found to be much more efficient than if driven in the usual way.

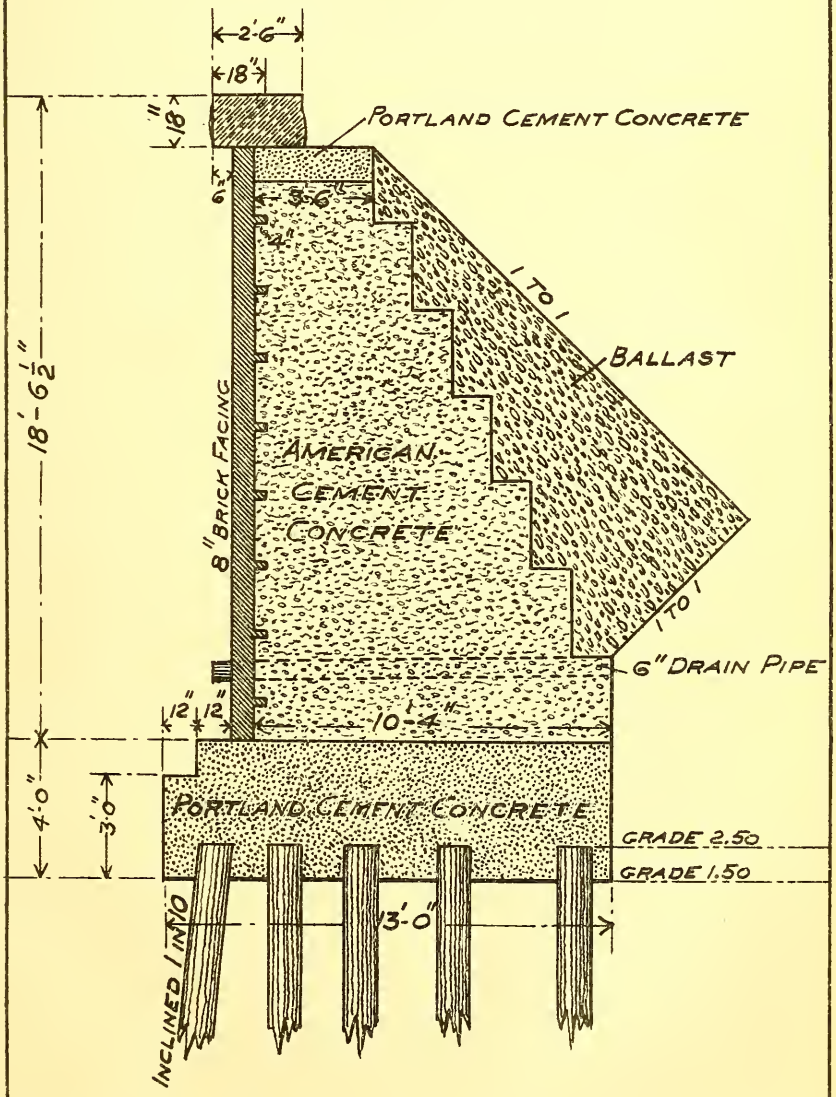
Estimates, detailed plans, specifications, and contract for building a foundation for head-house and rebuilding part of two ferry-piers at the East Boston landing of the North ferry have been furnished, and the contract for doing the work was awarded to Nay & Ellis, for $9,456. Work was begun Oct. 24 and continued to Dec. 31. Work cannot be resumed until the head-house now being built is ready for occupancy. The payments on account of the contract to Feb. 1, 1892, have been $3,219.80.

Plans, estimates, and specifications were made for building a wharf adjoining the new head-house; the contract for doing the work, with the exception of the planking, which was done

FERDINAND STREET BRIDGE.

SECTION OF RETAINING WALL.

—1891.—



by the Ferry Department, was awarded to Nay & Ellis, and completed Jan. 18, 1892, at a cost of $1,665.

Soundings have been taken and plans made showing depth of water in all of the ferry-slips, except at the East Boston side of the North ferry.

All of the above work has been done under the superintendence of this department.

HILL-STREET RETAINING-WALL.

See page 92.

IRVINGTON-STREET FOOT-BRIDGE (OVER PROVIDENCE DIVISION, OLD COLONY RAILROAD).

See page 92.

IRVINGTON-STREET AND YARMOUTH-STREET RETAINING-WALLS.

See page 92.

L-STREET ABUTMENT.

See page 93.

L-STREET BRIDGE.

The Legislature, at its session of 1891, passed the following act:

[CHAP. 388.]

AN ACT TO PROVIDE A PUBLIC HIGHWAY BRIDGE ACROSS THE RESERVED CHANNEL AT SOUTH BOSTON.

Be it enacted, etc., as follows:

SECTION 1. The city of Boston is hereby authorized and required to build and maintain a public highway bridge across the reserved channel on the South Boston flats in said city, connecting Eastern avenue or Congress street, so called, as laid out and graded by the Commonwealth, with L street extended to the southerly line of said channel. Said bridge shall be constructed in accordance with plans prescribed or approved by the Board of Harbor and Land Commissioners. Upon the completion of said bridge, provided the same is completed before the first day of August in the year eighteen hundred and ninety-two, forty per cent. of the cost thereof shall be reimbursed by the Commonwealth to said city out of the Commonwealth's flats improvement fund established by chapter two hundred and thirty-seven of the acts of the year eighteen hundred and seventy-eight.

SECTION 2. This act shall take effect upon its passage.

[*Approved June 9, 1891.*

Plans and specifications were prepared which received the approval of the Board of Harbor and Land Commissioners, Oct. 29, 1891. The work was advertised on Dec. 14, 1891,

soliciting proposals for the completion of the work at different dates; namely, July 15, 1892, and Dec. 1, 1892. The contract for the work has not been awarded at this date, pending action of the Legislature on a petition of His Honor the Mayor for an extension of the time for completing the work from Aug. 1 to Dec. 1, 1892.

L-street Bulkhead.

See page 93.

North Harvard-street and Essex-street Bridges, Brighton to Cambridge.

These bridges have been partly rebuilt for the purpose of providing them with draw channels 36 feet in width.

The work was done under the direction of the City Engineer of Boston, the City of Cambridge paying one-half the cost.

The work on North Harvard-street bridge was described in the last report, and was completed Feb. 9, 1891.

Essex-street bridge was opened to travel March 21, and was completed May 1, 1891.

Public Institutions.

Special examination of the wharves at Deer, Long, and Rainsford islands was made at the request of the commissioners, and a report submitted to them.

Roxbury-canal Sea-wall.

See page 93.

Savin Hill Avenue Bridge (over Old Colony Railroad).

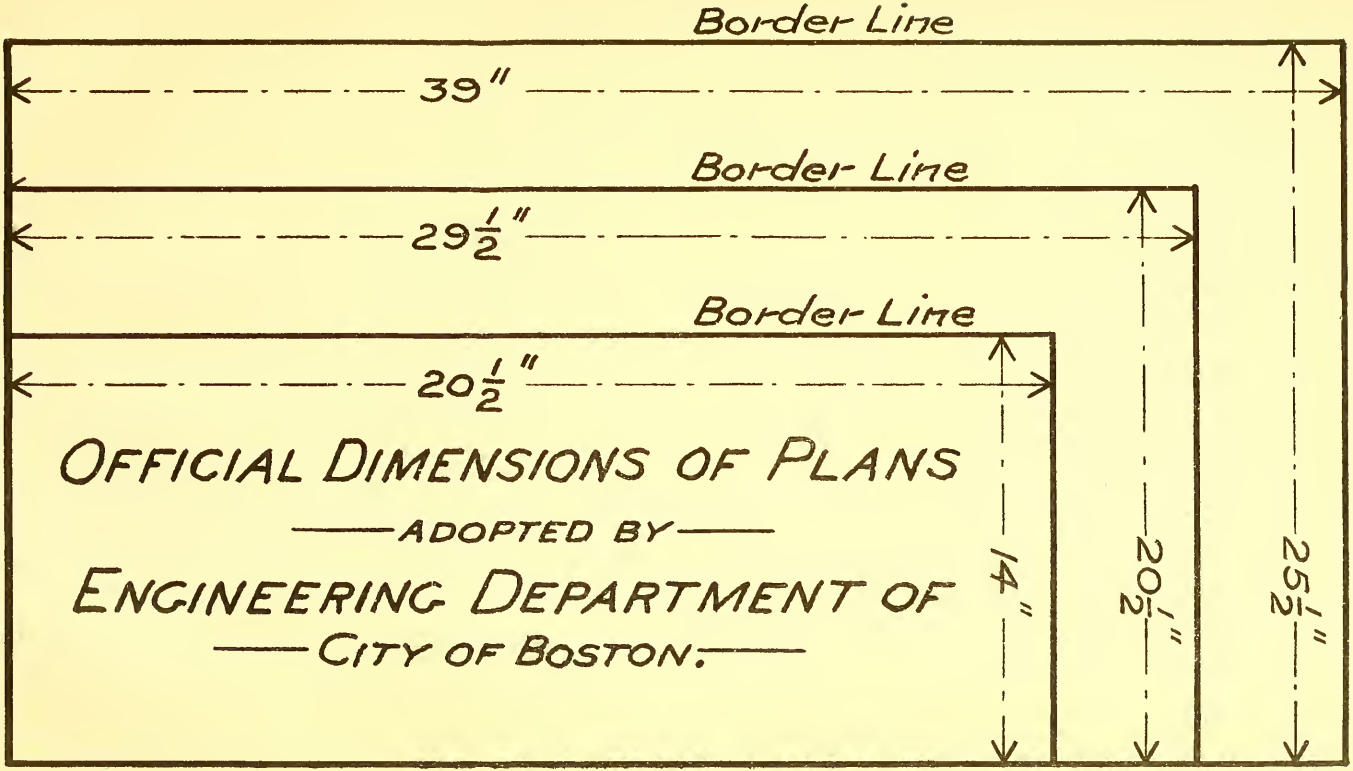
Plans for building a new bridge on Savin Hill avenue have been submitted by the Old Colony Railroad, and an agreement made with the railroad company for doing the work, the city to pay $5,000 of the cost thereof.

Stony-brook Improvement (Roslindale Branches).

See page 93.

Walks in Public Grounds.

Plans and specifications were made for concrete walks on the Common, from West-street entrance to Park-street steps,


Border Line
39"
Border Line
29½"
Border Line
20½"
OFFICIAL DIMENSIONS OF PLANS
ADOPTED BY
ENGINEERING DEPARTMENT OF
CITY OF BOSTON.
14"
20½"
25½"

the work being done by Simpson Bros., at a cost of $2,691.

Plans and specifications were also made for paving Montgomery square, walks on Blackstone square, and walk on the Common, from Tremont street, opposite Winter street to Beacon street, opposite Spruce street, with Hastings asphalt tiles.

The work was done by John Turner & Co., and cost as follows: Montgomery square, $814.00; Blackstone square, $3,900.00; and walk on Common, $3,676.40.

The above work was done under the supervision of this department.

Special Examination of Bridges.

Special examination of Broadway bridge, over New York & New England Railroad; Broadway bridge, over Fort Point Channel; Winthrop bridge, and Washington-street bridge, over New York & New England Railroad, were made to ascertain their strength under electric-railroad traffic.

Other work of a miscellaneous character was principally as follows:

Plans and Estimates.

For abolition of grade crossings at Washington street, Forest Hills, and at Cambridge street, Allston.

For elevating Chelsea bridge over the tracks of the Boston & Maine Railroad.

For tunnel for foot traffic at Franklin street, Allston.

For temporary bridge to Castle Island, and draw for same.

For a bridge to East Boston.

Estimates.

For a bridge for New York & New England Railroad, at Geneva avenue.

For filling on Ninth street, between G and H streets.

For a retaining-wall at corner of G and Ninth streets.

For rebuilding Western-avenue bridge to Watertown.

For rebuilding North Beacon street bridge to Watertown.

A large amount of miscellaneous office-work has also been done, such as making record plans, maps for Water and Park departments, and copying, tracing, and blue-printing plans.

In General.

About May 1, Assistant Engineer Henry Manley was assigned to the immediate direction of the several paving

contracts for the Street Department, and the work in progress of construction, which was in his charge, was assumed by Assistant City Engineer John E. Cheney in addition to his other duties.

RAPID TRANSIT.

By act of the Legislature for the year 1891, the City Engineer was made *ex officio* a member of the Rapid Transit Commission, and much time has been devoted to that commission.

B.

[FROM THE CITY ENGINEER'S REPORT TO THE BOSTON WATER BOARD.]

Sources of Supply.

The rainfall upon the water-sheds during the past year varied but little from the average amount, but less than the usual proportion fell during the summer and fall months, consequently the storage in the reservoirs began to be reduced in June and July, and steadily decreased until the latter part of December.

The rainfall and quantities collected on the several water-sheds were as follows:

	Sudbury.	Cochituate.	Mystic.
Rainfall in inches .	49.52	46.42	47.40
Rainfall collected, inches	27.612	32.07	28.60
Daily average yield of water-shed, gallons . . .	98,900,000	28,800,000	36,600,000

The quality of the water from all the supplies has been comparatively good.

The fluctuations in the amounts of water in the different lakes and reservoirs are shown graphically by an appended diagram.

The condition of the different reservoirs during the year is given below:

Reservoir No. 1. — Water was wasting at the dam from January 1 to July 2, with the exception of five days in May, after the stop-planks were placed on the dam, and during five days in June. No water wasted over the dam after July 2, and only the one and one-half million gallons per day was allowed to flow through the waste-gates, as required by law.

The dam is in good condition.

Reservoir No. 2. — Water was flowing over the dam or through the gates of Dam 2 until May 9, when the flash-boards were placed in position. The reservoir filled to the top of the flash-boards four days later, but water was drawn from this reservoir to supply the city on the 14th, and the surface immediately fell below the top of the flash-board, and the reservoir did not fill again during the year. The lowest point reached was on August 19, when the surface was 9.48 feet below the top of the flash-boards.

The dam at Reservoir 2 is in good condition.

Reservoir No. 3. — This reservoir was full until the middle of August, except during February and March, when it was drawn down in anticipation of the usual large spring flow. On August 19 this reservoir was drawn from to supply the city, and its surface gradually fell until November 24, when it was at grade 162.32, or 12.92 feet below the crest of the overflow.

On Jan. 1, 1892, it had risen to 167.19, or 8.05 feet below the crest.

The dam at Reservoir 3 is in good condition.

Reservoir No. 4. — This reservoir was kept full until July 15, with the exception that it was lowered as usual in the spring.

On July 15 the outlet gate was partially opened to furnish a portion of the city's supply, and the reservoir gradually fell until September 26, when the gate was closed. The height at that date was 202.91, or 12.30 feet below the top of the flash-boards. Since that date no water has been drawn from the reservoir, and its surface has gradually risen. On January 1 its height was 207.85, or 6.36 feet below the crest of the dam.

The dam of Reservoir No. 4 is in good condition.

Farm Pond. — The surface of the pond has been kept at an average height of 149.12.

The conduit through the pond has been in use all the year, no water having been drawn from the pond to supply the city.

The Framingham Water Company has pumped 80,500,000 gallons from the pond, an average of 220,500 gallons per day.

Lake Cochituate. — Water was wasted from the outlet dam from January 2 to 7, and from January 12 to April 25.

The surface of the lake began to fall on April 26, and continued to fall slowly and with great regularity until

November 26, when it was at grade 126.44, or 7.92 feet below high-water, the lowest point during the year.

The lake began to fill during the latter part of December, and on January 1 it had risen to grade 127.34, or 7.02 feet below high-water line.

The heights of water in the various storage reservoirs on the first day of each month are given below:

	Reservoirs.				Farm Pond.	Lake Cochituate.
	No. 1.	No. 2.	No. 3.	No. 4.		
	Top of Flash-boards.	Top of Flash-boards.	Crest of Dam.	Top of Flash-boards.	High-Water.	Top of Flash-boards.
	159.29	167.12	175.24	215.21	149.25	134.36
January 1, 1891	157.66	165.96	175.32	214.41	149.36	132.49
February 1, "	158.23	166.13	175.36	210.11	149.17	133.14
March 1, "	158.27	166.20	175.45	210.77	149.90	132.75
April 1, "	158.07	166.27	175.42	211.97	148.97	134.14
May 1, "	157.77	166.00	175.34	214.53	149.39	134.12
June 1, "	159.37	166.10	175.41	214.74	149.26	133.20
July 1, "	159.37	165.37	175.36	214.81	149.09	132.22
August 1, "	157.68	160.36	175.31	211.56	148.89	130.71
September 1, "	157.89	159.33	174.03	206.21	148.93	129.48
October 1, "	157.59	158.93	172.12	202.91	148.79	128.30
November 1, "	157.25	159.08	167.70	203.97	148.81	127.06
December 1, "	157.00	160.80	163.50	205.46	148.80	126.69
January 1, 1892	157.20	163.55	167.19	207.85	148.99	127.34

Water has been drawn from the different reservoirs as follows:

RESERVOIR NO. 1.

July 3 to 6, inclusive.

RESERVOIRS NOS. 1 AND 2.

July 2.

RESERVOIR NO. 2.

May 17 to 24.
May 28 to June 7.
June 9 to 10.
June 16 to 18.
June 30 to July 1.
July 7 to Aug. 18.
Sept. 15 to 24.
Dec. 20 to 31.

RESERVOIRS NOS. 2 AND 3.

Jan. 1 to 4.	April 8 to 11.
Jan. 7 to 11.	April 16 to 18.
Jan. 15 to 18.	April 20 to 26.
Jan. 22 to 26.	April 30 to May 3.
Jan. 29 to Feb. 1.	May 7 to 9.
Feb. 5 to 8.	May 14 to 16.
Feb. 12 to 15.	May 25 to 27.
Feb. 19 to 23.	June 11 to 14.
Feb. 27 to March 1.	Aug. 19 to Sept. 14.
March 5 to 8.	Sept. 25 to Oct. 26.
March 12 to 15.	Oct. 28 to Nov. 16.
March 19 to 22.	Nov. 19 to 29.
March 26 to 28.	Dec. 1 to 19.
April 1 to 4.	

AQUEDUCTS AND DISTRIBUTING RESERVOIRS.

The Sudbury-river conduit has been used 298 days, and the Cochituate has been used 352 days. The Sudbury conduit has delivered 8,306,600,000 gallons into Chestnut-hill and Brookline reservoirs, equal to a daily supply of 22,760,000 gallons; the Cochituate aqueduct has delivered 5,508,180,000 gallons, or 15,091,000 gallons per day.

In the Cochituate aqueduct a nearly uniform depth of six and one-half feet was maintained until the middle of October, when the surface of the lake had fallen so low that this depth could not be maintained.

During the balance of the year the depth in the aqueduct closely followed the depth in the lake above the bottom of the aqueduct, and at one time it was only five feet four inches.

The rate of flow in the Sudbury conduit was varied almost daily to maintain the desired height in the distributing reservoirs. Both conduits were cleaned as usual during the year.

On April 19 one of the 40-inch siphon-pipes of the Cochituate aqueduct at Newton Lower Falls was split by the weight of gravel-filling that had been deposited over the pipes in building a new street across the location of the siphon. The water was shut off and the split pipe replaced before any damage had been done.

The Chestnut-hill, Brookline, Fisher-hill, Parker-hill, and East Boston reservoirs, and the Breed's Island water-tower, are in good condition. I recommend that the elm-trees at the base of the Chestnut-hill reservoir dam be removed. The inside of the iron water-tower on Bellevue hill should be painted this year.

The South Boston reservoir has not been in daily use for many years, but is kept partially full of water for use in special emergencies, and for this reason is still of value to the water-supply service. A check-valve should be placed in the high-service connection with this reservoir, to automatically supply the fire-hydrants within the high-service district of South Boston in case of serious fires.

HIGH-SERVICE PUMPING-STATIONS.

At Chestnut hill the pumping-engines and boilers are in excellent condition.

A permanent apparatus for weighing the feed-water has been placed in the boiler-room, and the accuracy of the feed-water meters is now easily ascertained from time to time, so that corrections can be made in calculating the efficiency of the boilers.

The table on page 62 shows in detail the work done by the pumping-engines and boilers during the year.

Engine No. 1 was used 3,419¼ hours, pumping	1,264,475,610 gallons.
Engine No. 2 was used 3,768¼ hours, pumping	1,386,688,800 "
Total amount pumped	2,651,164,410 "
Total amount coal consumed	2,910,751 pounds.
Percentage ashes and clinkers	8.5
Average lift in feet	124.6
Quantity pumped per lb. of coal	910.8 gallons.
Daily average amount pumped	7,263,500 "

The amount pumped is an increase of 11.9 per cent. over that of 1890.

The same boiler supplied steam for pumping, and for heating and lighting the pumping-station and other buildings near the station.

COST OF PUMPING.

Salaries	$9,590 40
Fuel	6,558 28
Repairs	701 93
Oil, waste, and packing	534 51
Small supplies	257 18
Total	$17,642 30

Cost per million gallons raised one foot high	$0.053
Cost per million gallons pumped to reservoir	6.65

At the West Roxbury pumping-station 24,108,000 gallons have been pumped, equivalent to a daily average of 66,000 gallons, — an increase of 68.4 per cent. over that pumped in 1890.

At the East Boston pumping-station an average of 13,500 gallons per day has been pumped into the Breed's Island water-tower.

Water was pumped into the East Boston reservoir only on two days in January, one day in February, and two days in March, as the reservoir could be filled during the night from the low-service mains during the balance of the year.

Mystic Lake.

Water was wasted over the dam almost constantly until June 9, and again from June 22 to June 28. From this date the surface of the lake gradually fell until it was 7.67 feet below high-water on November 26, or only 3.50 feet above the bottom of the conduit. This was only about 4 inches above the point where the supply for the pumping-station could not be maintained by gravity.

Early in October the centrifugal pumps were placed in position at the lake to raise the water into the conduit, but fortunately it was not necessary to use them.

Advantage was taken of the low stage of the water to repoint the masonry at the overflow.

On January 1, 1892, the water in the lake had risen to grade 2.32, or 4.68 feet below high-water, and water was wasting over the dam on January 15.

The table on page 60 shows the yield of the water-shed. The rainfall there recorded is an average from two gauges, one located at the lake and one in Winchester.

The record of the latter gauge was kept by Mr. L. R. Symmes, formerly assistant superintendent, gratuitously until his death, last February. Since his death the gauge has been maintained and records kept by Miss A. F. Symmes.

Mystic Valley Sewer.

The pump was run 356 days during the year of 1891, working 6,391⅓ hours, and has pumped 119,404,000 gallons of sewage, or an average of 335,400 gallons per day of pumping. The amount pumped is only one-fourth of one per cent. greater than in 1890.

The total amount of sulphate of alumina used during the

year was 303,780 pounds, and 173 tons of coal were used in pumping.

MYSTIC CONDUIT AND RESERVOIR.

The conduit was cleaned twice during the year, and is in good condition.

New sills and grooves for the screens should be placed in the screen-chamber, and the roof of the chamber should be raised to facilitate the changing of the screens. A new gate should be placed on the blow-off pipe, to exclude the tide-water.

The reservoir has not been cleaned for several years, otherwise it is in good condition.

MYSTIC PUMPING-STATION.

The pumps have received quite extensive repairs, and are in good condition.

The three older boilers should have new fronts, to correspond with those on the new boilers; a sluice-gate should be placed in the pump-well of Engine No. 3, as under the present condition any accident to the foot-valve of this pump would necessitate the stopping of the whole plant. A duplicate dynamo for lighting the building should be procured, and it would be an economical measure to build a new chimney of larger capacity if the plant is to be continued in service.

The table on page 63 shows in detail the work done by the pumping-engines during the year.

Engine No. 1 was in use 884 hours, pumping	145,186,500 gallons.
Engine No. 2 was in use 1,774¼ hours, pumping	346,862,000 "
Engine No. 3 was in use 8,352½ hours, pumping	2,812,902,400 "
Total amount pumped	3,304,951,000 "
Total amount coal consumed	6,988,500 pounds.
Percentage ashes and clinkers	10.2
Average lift in feet	148.02
Quantity pumped per lb. of coal	472.9 gallons.
Average duty of engine per 100 lbs. of coal, no deductions	58,380,500 ft.-lbs.
Daily average amount pumped	9,054,700 gallons.

The amount pumped is an increase of 9.1 per cent. over that of 1890.

COST OF PUMPING.

Salaries	$9,628 07
Fuel	13,946 42
Repairs	954 69
Oil, waste, and packing	983 96
Small supplies	444 89
Total	$25,958 03

Cost per million gallons raised one foot high	$0.053
Cost per million gallons pumped to reservoir	7.85

CONSUMPTION.

The daily average consumption from the combined works, and the consumption, compared with that of 1890, was as follows:

	COCHITUATE WORKS.		MYSTIC WORKS.		COMBINED SUPPLIES.	
	Consumption in Gallons.	Percentage of Consumption of 1890.	Consumption in Gallons.	Percentage of Consumption of 1890.	Consumption in Gallons.	Percentage of Consumption of 1890.
January	37,230,100	110.5	9,389,300	114.7	46,619,400	111.3
February	37,280,700	112.9	9,466,900	114.1	46,747,600	113.1
March	35,533,400	115.2	8,811,000	109.4	44,344,400	114.0
April	35,751,600	117.3	8,045,800	107.5	43,797,400	115.4
May	36,580,700	116.6	8,841,300	113.1	45,421,900	113.9
June	37,801,900	114.5	9,478,400	112.9	47,280,300	114.2
July	39,062,500	106.4	9,581,700	101.3	48,644,200	105.4
August	39,460,400	108.7	9,122,300	102.1	48,582,800	107.4
September	40,677,700	112.5	9,128,700	108.2	49,806,400	111.7
October	38,845,600	116.3	9,259,100	118.9	48,104,800	116.8
November	36,640,800	111.2	8,585,200	112.9	45,226,000	111.5
December	37,342,500	97.4	8,960,600	94.6	46,303,10 0	96.9
Average	37,686,900	111.3	9,055,200	109.1	46,742,100	110.8

The daily average consumption per head of population was as follows:

Sudbury and Cochituate supply,	89.3 gallons.
Mystic supply	74.7 "
Combined supplies . . .	86.0 "

The above figures show an increase of 11.3 per cent. in the consumption supplied from the Sudbury and Cochituate works from that of the previous year; of 9.1 per cent. in the consumption supplied from the Mystic works; and of 10.8 per cent. increase in the consumption supplied by the combined supplies.

Deacon Meters.

There are now in use 81 meters, — 74 on the Cochituate system and 7 on the Mystic system, — and the territory covered by the meters is divided into 176 sections; 8 sections were not tested during the past year.

The quantity supplied to the entire residential portion of Boston can now be tested by the meters, excepting a portion of West Roxbury and that portion of the Back Bay district bounded by Boylston street, Parker street, and the Boston & Providence Railroad.

During the coming year two meters should be placed in the latter territory; but the West Roxbury district cannot be advantageously tested until the district is more densely populated.

On the Mystic system Charlestown is practically covered by meters; one meter covers a small portion of Somerville, and one about one-quarter of Chelsea. Everett has no meters.

The estimated population supplied with water, and the population that is covered by Deacon meters in the different sections of the city, is as follows:

Section.	Estimated Population.	Population on Meters.
City proper	164,875	132,000
Roxbury	104,000	84,000
West Roxbury . . .	28,510	14,300
Dorchester	34,025	27,500
Brighton	13,700	5,400
South Boston . . .	76,535	65,000
East Boston . . .	41,375	32,000
Charlestown . . .	45,930	32,500
Chelsea	33,775	9,300
Somerville	46,675	4,400

The consolidated results of the readings of the various sections is shown in the following table, in which is given the final reading of 1890, the first and last readings of this year, the differences between the first and second readings of this year, and the differences between the last readings of this year and those of 1890.

Cochituate System.

SECTION.	Population.	1890. 2d Reading.		1891. 1st Reading.		1891. 2d Reading.	
		Daily con.	Night rate.	Daily con.	Night rate.	Daily con.	Night rate.
City proper	132,000	52.5	29.4	56.9	35.3	61.7	37.5
Roxbury	84,000	49.2	28.8	58.1	36.4	53.5	36.8
West Roxbury	14,300	53.3	23.1	50.6	23.1	. . . .	. . . .
Dorchester	27,500	49.0	25.8	52.8	25.2	49.9	27.7
Brighton	5,400	52.1	24.0	61.3	27.1	. . . .	. . . .
South Boston	65,000	40.5	24.0	41.3	25.6	47.3	26.6
East Boston	32,000	34.5	20.2	35.7	24.2	39.9	25.6
	360,200	47.5	27.6	52.1	31.8	53.7	33.2

Mystic System.

Charlestown	32,500	33.8	17.8	40.6	24.0	41.5	25.2
Somerville	4,400	43.2	26.2	82.1	48.5	78.3	58.8
Chelsea	9,300	37.2	24.9	44.4	29.5	43.1	32.3
	46,200	35.3	20.0	45.1	27.3	45.2	29.6

ADDITIONAL SUPPLY.

At Dam No. 6 the excavation for the core-wall has been completed, the wall built in the trench, and the trench refilled. This work was difficult; the building of the core-wall could not be done at a rapid rate, great care being necessary in removing the bracing and in doing the refilling.

The embankment and core-wall of the dam have been built to about five feet above the elevation of the lowest part of the valley, and the work is now in such condition that comparatively rapid progress can be made, all of the difficult work having been done.

The work of stripping the basin and the shallow-flowage work is well advanced. It will probably be completed this year.

The surveys of Cedar swamp, and the plans for its improvement, are practically completed. At Whitehall pond surveys and borings are being made for a new dam at the outlet; a dredging plant has been built, and the work of removing mud and stumps from the bottom of the pond can be commenced in the spring.

On the Stony-brook branch of the Sudbury, surveys and borings are being made for Basins 5, 7, and 9, the construction of which must soon be commenced, as the increased consumption of water, due to the growth of the city, will keep pace with the increased capacity to be added by the completion of Basin No. 6.

For particulars see the following report of Desmond FitzGerald, Resident Engineer:

BOSTON WATER-WORKS, OFFICE OF ADDITIONAL SUPPLY,
SOUTH FRAMINGHAM, MASS., Feb. 1, 1892.

WILLIAM JACKSON, Esq., *City Engineer:*

SIR: I submit herewith a brief report of engineering work accomplished during the past year by the "Additional Supply" force.

The name of Basin 5 has been changed to Basin 6, in order to bring all the even numbers on the Sudbury branch of the supply. Although the core-wall of this basin was heavily covered with hay, the frost got into the trench in January, 1891, and attacked the concrete, even at the bottom of the trench, 30 feet deep, necessitating the laying of steam-pipes. January 9 a contract was made with Charles H. Hale for delivering filling on the dam. April 6 the trench was uncovered and pumped out. May 5 the work of depositing concrete was begun. June 3 the core-wall was completed, and the back-filling begun, the sheeting being cut off in sections about 2 feet high, in order that the back-filling might be thoroughly rammed and bonded to the sides of the trench. On September 2 the back-filling reached the surface of the ground, and the embankment was begun. September 29 the contractor suspended operations, and on October 9 the work was continued by the bondsman, Mr. Barnabas Clark. The embankment has been built to the height of five feet above the meadow. A gap 20 feet wide was left in the core-wall to pass freshets during the winter and spring.

The gate-house for the 48-inch pipe has been built and the

pipe laid on rock foundation and covered with brickwork. It discharges into the wasteway, the lower section of which has been built. The upper gate-house has been begun. All gate-house, pipe, and core-wall trenches have been back-filled.

May 25 a contract was made with Charles H. Hale for building the lower section of the wasteway, 220 feet long, and on September 24 the work was completed.

July 14 four sections for stripping the bottom of the basin were let, and about two-fifths of this work has been done in a satisfactory and economical manner.

During the latter part of the summer a railroad was built connecting the Boston & Albany R.R. with the basin. After its completion about 25,000 cubic yards of loam were hauled to the Muddy-river Improvement on behalf of the town of Brookline.

The principal specifications and contracts prepared during the year were those for the stripping and shallow flowage, the railroad, and the lower section of the wasteway. The following table shows the work accomplished thus far at the new basin:

WORK DONE AT BASIN 6 DURING 1890 AND 1891.

	1890.	1891.
Clearing	19 acres.	23 acres.
Stripping earth (city contract)	47,891 cu. yds.	50,940 cu. yds.
Stripping earth (contract),	0 "	175,000 "
Stripping rock	2,125 "	536 "
Collecting stone	15,953 "	4,423 "
Trench excavation, earth	19,450 "	4,641 "
Trench excavation, rock	1,018 "	1,051 "
Crushing stone	6,857 "	2,994 "
Concrete	7,179 "	2,498 "
Plaster	2,174 "	2,132 "
Back-filling	507 "	10,875 "
Embankment	5,362 "	15,928 "
Screening sand and gravel,	4,221 "	2,751 "
Rubble-stone delivered	19 "	466 "
Stone-masonry	0 "	534 "
Brick-masonry	35 "	291 "
Delivering clay (city labor),	0 "	593 "
Laying 48-inch pipe	0 lin. ft.	414 lin. ft.
Laying 36-inch pipe	0 "	12 "
Loaming embankment	0 c. y.	322 c. y.
Wasteway	0 lin. ft.	220 lin. ft.

Surveys have been continued on various portions of the water-shed. The work of lining the Beacon-street tunnel has been prosecuted from Dec. 30, 1890, to May 14, 1891. The cost of laying the concrete was $13.14 this year against $15.02 last year.

Yours very truly,

(Signed) Desmond FitzGerald,
Resident Engineer.

In General.

The sewerage system of the city of Marlboro' is well advanced, the main sewer is completed, the filtration areas are prepared, and a considerable portion of the service-sewers are laid. The system will be in operation early this year, and it will greatly improve the quality of the water collected by the Stony-brook branch of the Sudbury river.

The sewerage system of the town of Westboro' is under construction, and will probably be in operation in the near future.

Work has been begun upon the foundations of the new pumping-engine at Chestnut-hill pumping-station, and the plans for the engine are nearly completed.

The daily amount pumped at this station increases about 12 per cent. each year, and will exceed the nominal capacity of one pumping-engine next year; consequently the work on the new engine must be pushed as rapidly as possible.

At the Mystic station the pumps are duplicated to a capacity of 10,000,000 gallons per day, and at the present rate of increase the daily average consumption in 1893 will exceed this amount.

In this connection I wish to call attention to the fact that the total capacity of the Mystic system is but 7,000,000 gallons daily in a dry year, and to recommend that the dependant municipalities make some provision to meet the inevitable deficiency which must sooner or later occur.

Thirty-seven contracts for rock excavation have been made during the year. Two hundred and ninety-nine petitions for main-pipe extensions have been reported upon in regard to grade of street, size of pipe, and cost of laying.

The pipe laid has been measured, the gates and hydrants located, and are being plotted on the plans.

Thirty-five profiles of unaccepted streets have been made, and grades given for grading the streets and laying pipes where it was necessary.

The records from the four pumping-stations, the lakes, reservoirs, the Mystic sewer, and the returns from pipe foundries, etc., have been carefully kept.

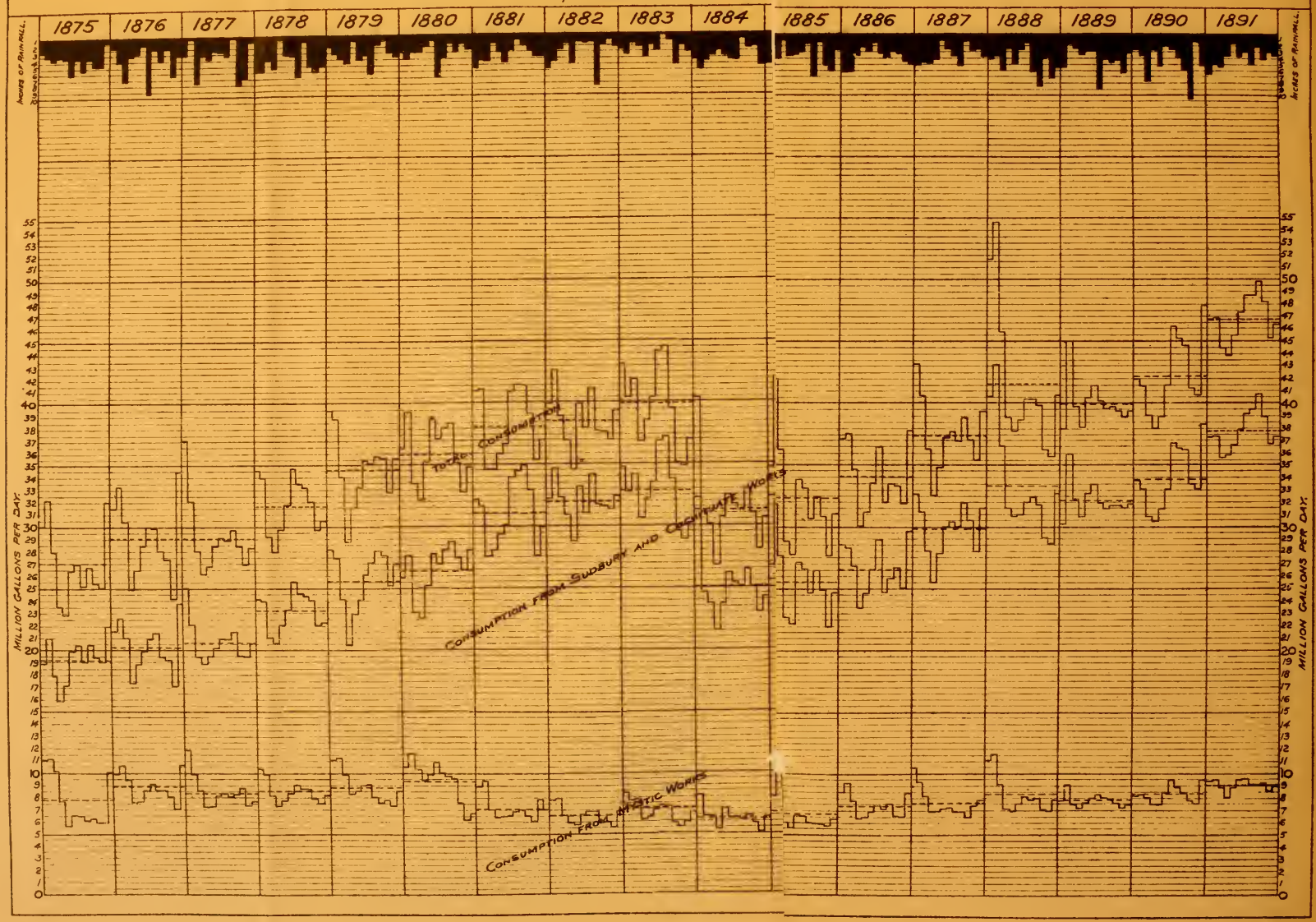
Appended to this report will be found the usual tables of rainfall, consumption, yield of water-sheds, etc.

K5.
Consumption
1885
1886
1887
1888
1889
1890
1891

BOSTON WATER WORKS.

Diagram showing the rainfall and daily average Consumption for each month.

Yearly Averages shown thus ------.



HELIOTYPE PRINTING CO. BOSTON

Daily Average Consumption of Water, in Gallons, from the Cochituate and Mystic Works.

	COCHITUATE WORKS.							MYSTIC WORKS.						
MONTH.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
January	26,711,900	28,561,900	32,687,600	40,485,700	30,172,000	33,680,000	37,230,100	7,855,400	8,510,300	10,488,600	11,107,100	7,769,500	8,187,900	9,389,300
February	31,847,400	28,291,100	31,224,300	43,105,000	35,855,200	33,030,700	37,280,700	10,019,500	9,275,700	9,346,700	11,620,900	9,073,600	8,299,700	9,466,900
March	27,697,200	26,886,800	28,124,100	36,463,400	32,180,000	30,844,400	35,533,400	8,487,500	7,780,000	8,175,000	9,242,000	7,537,600	8,055,800	8,811,000
April	22,720,450	23,470,400	25,591,500	31,473,800	30,814,500	30,446,600	35,751,600	6,042,600	6,636,500	6,933,800	7,276,700	7,185,700	7,481,600	8,045,800
May	22,168,400	24,680,100	27,925,000	30,802,000	32,719,500	31,381,200	36,580,700	5,605,700	6,444,000	6,916,300	6,932,300	7,663,600	7,488,400	8,841,300
June	27,214,800	26,574,900	30,069,000	31,026,100	33,377,900	33,022,700	37,801,900	6,594,200	6,941,100	7,159,800	7,615,200	8,017,700	8,396,000	9,478,400
July	26,606,200	28,987,500	30,469,700	32,014,400	31,870,300	36,701,100	39,062,600	6,513,300	7,437,500	7,250,000	8,267,500	8,315,600	9,463,300	9,581,700
August	24,686,400	24,770,600	30,063,100	32,432,700	31,403,200	36,316,000	39,460,400	6,047,600	7,166,800	6,871,900	7,859,100	8,113,200	8,932,200	9,122,300
September . . .	26,493,600	25,835,600	31,946,600	31,836,500	31,722,800	36,165,800	40,677,700	5,931,900	7,585,200	6,868,600	7,266,300	7,966,000	8,436,700	9,128,700
October	24,945,500	26,713,100	30,562,700	29,110,800	31,702,200	33,429,800	38,845,600	5,914,900	6,552,000	6,436,600	7,096,400	7,627,500	7,784,100	9,259,100
November . . .	21,942,750	25,036,200	28,062,000	28,590,900	31,532,400	32,955,100	36,640,800	5,710,300	6,546,000	7,361,200	6,990,800	7,316,700	7,601,300	8,585,200
December	24,724,900	29,706,800	31,511,500	32,686,200	31,829,000	38,334,100	37,342,500	6,356,700	8,043,500	7,835,300	7,918,600	7,473,200	9,448,300	8,960,600
Yearly average .	25,607,200	26,627,900	29,852,100	33,310,700	32,070,000	33,871,700	37,686,900	6,737,350	7,399,800	7,629,000	8,258,400	7,830,500	8,301,400	9,055,200

Diversion of Sudbury-River Water, 1883-91.

MONTH.	1883.		1884.		1885.	1886.	1887.	1888.	1889.		1890.	1891.
	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Lake Cochituate.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.	To Chestnut-Hill Res'r.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*
January . . .	. . . . .	733,400,000	. . . . .	697,000,000	473,900,000	502,200,000	602,200,000	895,400,000	. . . . .	484,500,000	518,600,000	715,900,000
February . . .	. . . . .	597,800,000	1,094,300,000	265,400,000	560,400,000	380,800,000	472,000,000	906,700,000	. . . . .	564,600,000	475,000,000	560,800,000
March	17,200,000	634,700,000	. . . . .	312,500,000	495,900,000	467,400,000	456,700,000	691,400,000	. . . . .	584,500,000	498,600,000	573,200,000
April	967,900,000	535,700,000	. . . . .	228,800,000	350,400,000	307,000,000	385,400,000	468,800,000	. . . . .	490,500,000	417,000,000	641,900,000
May	260,000,000	613,800,000	. . . . .	268,400,000	308,500,000	344,700,000	444,200,000	566,300,000	233,400,000	615,700,000	536,300,000	740,300,000
June	. . . . .	631,600,000	168,400,000	414,500,000	768,000,000	427,100,000	463,600,000	489,000,000	. . . . .	567,600,000	513,100,000	629,500,000
July	. . . . .	754,300,000	152,000,000	430,100,000	434,600,000	534,500,000	387,500,000	528,900,000	. . . . .	534,000,000	664,100,000	755,100,000
August	. . . . .	640,900,000	1,600,000	406,100,000	401,100,000	463,100,000	352,800,000	626,600,000	. . . . .	443,700,000	625,500,000	722,900,000
September . .	. . . . .	467,100,000	. . . . .	442,200,000	386,100,000	414,700,000	577,300,000	581,600,000	. . . . .	475,500,000	606,400,000	732,400,000
October	. . . . .	483,300,000	. . . . .	432,900,000	368,300,000	474,100,000	672,300,000	435,900,000	. . . . .	414,100,000	539,900,000	715,300,000
November . .	. . . . .	580,800,000	. . . . .	363,900,000	297,600,000	381,800,000	607,100,000	410,900,000	. . . . .	454,600,000	526,000,000	752,200,000
December . . .	. . . . .	536,800,000	. . . . .	432,500,000	379,900,000	570,200,000	703,000,000	605,200,000	. . . . .	501,200,000	675,500,000	767,100,000
Totals . . .	1,245,100,000	7,209,900,000	1,416,300,000	4,694,300,000	5,224,700,000	5,267,600,000	6,124,100,000	7,224,700,000	233,400,000	6,130,500,000	6,596,000,000	8,306,600,000
Tot'l div'rsion from Sudbury river	8,455,000,000		6,110,600,000		5,224,700,000	5,267,600,000	6,124,100,000	7,224,700,000	6,363,900,000		6,596,000,000	8,306,600,000
Average daily diversion for whole year	23,164,400		16,695,600		14,314,200	14,431,800	16,778,400	19,739,600	17,435,300		18,071,200	22,757,800

Statement showing Amount of Water diverted from Sudbury River to Lake Cochituate and Chestnut-Hill Reservoir; Amount wasted; Amount of Flow in River; Percentage of Rainfall collected, etc., 1875 to 1891.

(Water-shed from 1875 to 1878, inclusive, = 77.764 sq. miles; in 1879 and 1880 = 78.238 sq. miles; and from 1881 to 1891, inclusive, = 75.2 sq. miles.

YEAR.	Amount of Water diverted to Lake Cochituate and Chestnut-Hill Reservoir.	Amount of Water used by Framingham Water Co.	Amount of Water wasted from River.	STORAGE.		Total amount of flow in River.	Daily average amount of flow in River.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Inches.*	*Per cent.*
1875	2,555,800,000	. . . . .	24,971,600,000	66,300,000	. . . . .	27,593,700,000	75,599,200	45.490	20.418	44.88
1876	2,528,300,000	. . . . .	29,942,300,000	. . . . .	160,700,000	32,309,900,000	88,278,400	49.563	23.908	48.24
1877	1,894,350,000	. . . . .	32,433,300,000	112,100,000	. . . . .	34,444,750,000	94,369,200	44.018	25.487	57.90
1878	3,422,100,000	. . . . .	37,125,200,000	654,700,000	. . . . .	41,202,000,000	112,882,200	57.931	30.487	52.63
1879	3,749,200,000	. . . . .	20,817,500,000	962,200,000	. . . . .	25,528,900,000	69,942,200	41.419	18.775	45.33
1880	6,230,200,000	. . . . .	11,290,000,000	. . . . .	958,600,000	16,561,600,000	42,250,300	38.177	12.182	31.91
1881	8,845,300,000	. . . . .	17,279,000,000	751,700,000	. . . . .	26,876,000,000	73,633,900	44.169	20.565	46.56
1882	7,735,200,000	. . . . .	16,273,900,000	. . . . .	352,600,000	23,656,600,000	64,812,300	39.394	18.102	45.95
1883	8,455,000,000	. . . . .	7,251,900,000	. . . . .	1,086,400,000	14,620,500,000	40,056,200	32.780	11.188	34.13
1884	6,110,600,000	. . . . .	23,228,900,000	1,744,600,000	. . . . .	31,084,100,000	84,929,200	47.135	23.784	50.46
1885	5,224,700,000	61,300,000	19,378,300,000	. . . . .	446,900,000	24,718,400,000	67,721,600	43.545	18.916	43.44
1886	5,266,600,000	76,600,000	23,023,000,000	1,464,500,000	. . . . .	29,831,700,000	81,730,700	46.065	22.825	49.55
1887	6,124,100,000	87,500,000	25,334,500,000	117,400,000	. . . . .	31,663,500,000	86,749,300	42.705	24.227	56.73
1888	7,224,700,000	61,500,000	39,040,500,000	390,600,000	. . . . .	46,717,300,000	127,642,900	57.465	35.749	62.21
1889	6,363,900,000	59,500,000	31,550,400,000	. . . . .	2,800,000	37,971,000,000	104,030,100	49.95	29.056	58.17
1890	6,596,000,000	74,500,000	28,667,100,000	. . . . .	57,400,000	35,280,200,000	96,658,100	53.00	26.998	50.94
1891	8,306,600,000	80,500,000	28,799,600,000	. . . . .	1,100,800,000	36,085,900,000	98,865,500	49.52	27.612	55.76
Averages.	5,684,332,400	71,700,000	24,524,100,000	. . . . .	. . . . .	30,361,361,800	82,949,600	46.019	22.957	49.10

Statement showing Amount of Water drawn from Lake Cochituate; Amount wasted; Amount of Rainfall collected in Lake; Amount received into Lake from Sudbury River; Percentage of Rainfall collected, etc., 1852 to 1891; Water-shed of Lake, 12,077 Acres.

Year.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Amount received into Lake from Sudbury River.	Storage.		Total amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
				Gain.	Loss.					
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Inches.*	*Per cent.*
1852[1]	2,974,042,800	4,020,566,900	.....	.....	261,360,000	6,733,249,700	18,396,900	47.93	20.61	43.
1853	3,117,939,500	3,166,417,500	.....	239,580,000	.....	6,523,937,000	17,873,800	55.73	19.51	35.
1854	3,614,230,000	4,187,733,000	.....	.....	217,800,000	7,584,163,000	20,778,500	43.15	22.87	53.
1855	3,776,399,500	No account kept	.....	.....	326,700,000	.....	.....	34.96	.....	.....
1856	4,409,787,600	"	.....	598,950,000	.....	.....	.....	40.80	.....	.....
1857	4,644,990,000	10,625,900,000	.....	32,670,000	.....	15,303,560,000	41,927,600	63.10	46.69	74.
1858	4,689,155,000	1,934,500,000	.....	.....	141,570,000	6,482,085,000	17,759,000	48.66	19.46	40.
1859[2]	4,808,875,000	7,569,000,000	.....	283,140,000	.....	12,661,015,000	34,687,700	49.02	38.24	78.
1860	6,309,108,000	None.	.....	174,240,000	.....	6,483,348,000	17,714,100	55.44	19.40	35.
1861	6,639,095,900	3,377,559,000	.....	.....	1,459,260,000	8,557,394,900	23,444,900	45.44	25.45	56.
1862	6,059,000,000	33,200,000	.....	1,306,800,000	.....	7,399,000,000	20,271,200	49.69	22.36	45.
1863	5,927,052,500	2,165,696,500	.....	762,300,000	.....	8,855,049,000	24,260,400	69.30	26.88	39.
1864	6,105,306,700	1,368,746,000	.....	.....	1,848,577,000	5,625,475,700	15,370,200	42.60	18.35	43.
1865	4,621,630,000	1,688,120,700	.....	743,242,500	.....	7,052,993,200	19,323,300	49.46	20.50	41.
1866	4,463,585,000	None.	.....	743,242,500	.....	5,206,827,500	14,265,300	62.32	16.01	26.
1867	4,951,225,000	2,482,041,000	.....	.....	698,311,000	6,734,455,000	18,450,600	56.25	21.80	39.
1868	5,405,515,000	2,507,684,000	.....	346,371,000	.....	8,259,570,000	22,567,200	49.71	24.98	50.

1869	5,503,751,000	1,635,570,000	. . . . .	480,882,000	. . . . .	7,620,203,000	20,877,300	64.34	21.99	34.
1870	5,477,810,000	4,818,971,000	. . . . .	. . . . .	1,736,085,000	8,560,696,000	23,453,900	55.89	26.08	47.
1871	5,223,500,900	None.	. . . . .	. . . . .	250,933,000	4,972,567,000	13,623,500	45.39	15.16	33.
1872	5,775,151,200	None.	1,676,666,400	1,543,995,500	. . . . .	5,642,480,300	15,416,600	48.47	17.22	35.
1873	6,511,826,900	2,917,977,000	. . . . .	. . . . .	515,132,000	8,914,671,900	24,423,800	45.43	27.13	60.
1874	6,623,972,900	1,145,851,700	. . . . .	. . . . .	1,367,715,000	6,402,109,600	17,540,000	35.93	19.52	54.
1875	7,092,955,500	None.	2,555,800,000	1,222,885,000	. . . . .	5,760,040,500	15,780,900	45.49	17.57	39.
1876	7,277,175,200	1,619,243,800	2,528,300,000	43,438,000	. . . . .	6,411,557,000	17,517,900	48.49	19.54	40.
1877	7,626,889,200	1,484,978,600	1,894,350,000	378,727,000	. . . . .	7,596,244,800	20,811,600	43.80	23.17	53.
1878	7,743,904,700	3,341,875,000	2,668,300,000	219,789,000	. . . . .	8,637,268,700	23,663,700	53.58	26.34	49.
1879	6,051,838,900	1,523,361,400	411,300,000	. . . . .	1,322,697,300	5,841,203,000	16,003,300	38.01	17.81	47.
1880	4,284,147,100	65,577,700	826,700,000	. . . . .	146,265,000	3,376,759,800	9,226,100	35.83	10.30	29.
1881	2,846,459,700	2,231,016,700	187,600,000	468,089,400	. . . . .	5,357,965,800	14,679,400	41.09	16.34	40
1882	3,935,490,600	1,358,543,700	. . . . .	. . . . .	357,334,700	4,936,699,600	13,525,200	40.29	15.05	37.
1883	4,731,227,700	162,361,800	1,245,100,000	. . . . .	334,400,000	3,314,089,500	9,079,700	31.20	10.11	32.
1884	4,533,156,450	1,842,837,100	1,416,300,000	1,340,436,700	. . . . .	6,300,130,250	17,213,450	45.57	19.21	42.
1885	4,091,674,900	1,006,622,800	. . . . .	8,594,800	. . . . .	5,106,892,500	13,991,500	43.66	15.57	36.
1886	4,432,536,100	3,116,283,200	. . . . .	. . . . .	360,662,000	7,188,157,300	19,693,600	46.97	21.92	47.
1887	4,802,120,700	3,658,652,900	. . . . .	. . . . .	763,205,000	7,697,568,600	21,089,200	41.58	23.47	56.
1888	4,968,503,100	4,229,200,000	. . . . .	959,309,000	. . . . .	10,157,012,100	27,751,400	56.93	30.97	54.
1889	5,570,423,600	3,373,929,000	233,400,000	454,766,800	. . . . .	9,165,719,400	25,111,600	50.23	27.95	56.
1890	5,722,170,800	2,380,441,200	. . . . .	. . . . .	64,166,300	8,038,445,700	22,023,100	51.23	24.51	48.
1891	5,508,178,900	6,064,000,000	. . . . .	. . . . .	1,056,057,800	10,516,121,100	28,811,300	46.42	32.07	69.
Averages	5,221,295,100	2,450,125,200	. . . . .	. . . . .	. . . . .	7,288,861,200	19,958,000	47.98	22.16	46.

[1] Observation of rainfall at Lake Cochituate commenced 1852, and these observations are assumed as correct for the whole district.
[2] Lake raised two feet.

Statement showing Amount of Water drawn from Mystic Lake; Amount wasted; Amount of Rainfall collected in Lake; Percentage of Rainfall collected, etc., 1876 to 1891; Water-shed of Lake, 17,200 Acres.

Year.	Amount of Water drawn from Lake.	Amount of Water wasted from Lake.	Storage.		Total amount of Rainfall collected in Lake.	Daily average amount of Rainfall collected in Lake.	Rainfall.	Rainfall collected.	Percentage of Rainfall collected.
			Gain.	Loss.					
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Gallons.*	*Inches.*	*Inches.*	*Per cent.*
1876	3,230,101,300	6,369,774,700	.....	32,583,000	9,567,293,000	26,140,100	47.00	20.49	43.6
1877	3,069,554,800	7,250,223,500	.....	16,291,400	10,303,486,900	28,228,700	43.095	22.06	51.2
1878	3,367,490,400	8,718,547,600	.....	26,000,000	12,060,038,000	33,041,200	54.065	25.82	47.8
1879	3,490,848,200	4,625,691,800	.....	203,000,000	7,913,540,000	21,680,900	35.30	16.94	48.0
1880	3,692,195,700	2,158,761,200	.....	113,500,000	5,703,756,900	15,584,000	34.42	12.21	35.5
1881	2,815,579,900	5,534,300,000	371,200,000	.....	8,721,079,900	23,893,400	41.91	18.67	44.5
1882	2,570,896,700	4,444,668,000	15,000,000	.....	7,030,564,700	19,261,800	39.165	15.05	38.4
1883	2,664,514,200	2,034,702,600	.....	347,579,000	4,351,637,800	11,922,300	31.22	9.32	29.84
1884	2,469,761,000	6,574,003,800	380,600,000	.....	9,424,364,800	25,749,600	44.39	20.18	45.46
1885	2,639,278,800	5,558,860,500	.....	33,200,000	8,194,939,300	22,451,900	44.50	17.55	39.43
1886	2,862,947,500	7,743,258,900	.....	28,400,000	10,577,806,400	28,980,300	45.56	22.65	49.71
1887	2,954,257,500	7,414,213,000	.....	11,000,000	10,357,470,500	28,376,600	46.42	22.17	47.77
1888	3,205,121,100	11,334,593,100	.....	6,000,000	14,533,714,200	39,709,600	56.745	31.12	54.84
1889	3,007,539,800	8,879,787,500	12,000,000	.....	11,899,327,300	32,600,900	50.395	25.48	50.56
1890	3,212,284,500	8,953,727,900	.....	3,000,000	12,163,012,400	33,323,300	49.37	26.04	52.75
1891	3,500,817,500	10,027,714,400	.....	171,000,000	13,357,531,900	36,600,000	47.40	28.60	60.34
Average	3,047,074,300	6,728,301,800	.....	.....	9,759,972,800	26,721,300	44.435	20.90	46.23

Boston Water Works.

Diagram showing the heights of Sudbury River Reservoirs, Farm Pond, and Cochituate and Mystic Lakes; and the Rainfall on the Sudbury River Water Shed during the year 1891.

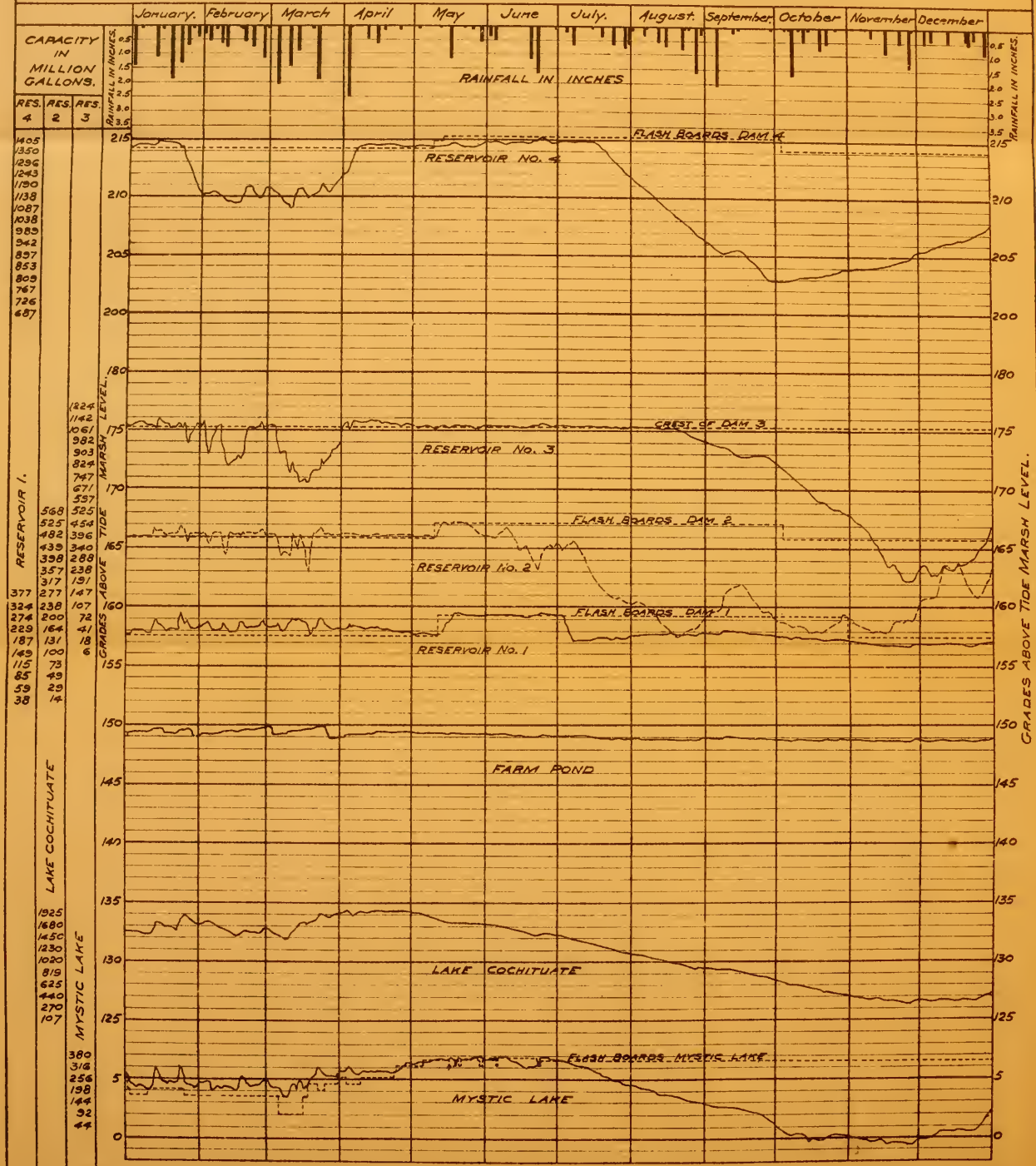


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Table showing the Average Monthly and Yearly Heights above Tide-marsh Level of the Water in the Lakes and Reservoirs of the Boston Water Works.

MONTHS.	Reservoir No. 1. Flash boards. 159.29.		Reservoir No. 2. Flash boards. 167.12.		Reservoir No. 3. Stone crest. 175.24.		Reservoir No. 4. Flash boards. 215.21.		Farm Pond. High water. 149.25.		Lake Cochituate. High water. 134.36.		Chestnut-Hill Reservoir. High water. 124.00.		Brookline Reservoir. High water. 124.00.		Parker-Hill Reservoir. High water. 219.00.		Mystic Lake. High water. 7.00.		Mystic Reservoir. High water. 147.00.		Fisher-Hill Reservoir. High water. 241.00.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
January .	157.95	158.23	166.12	166.20	175.55	175.32	214.53	213.85	149.64	149.48	132.49	132.95	123.45	123.48	123.02	123.25	. . .	218.78	5.53	4.75	146.75	149.66	239.22	240.12
February .	157.99	158.33	166.15	166.06	175.57	174.41	214.54	210.14	149.27	149.53	132.38	132.73	123.42	123.43	123.24	123.20	218.48	218.77	5.44	4.56	146.77	146.87	239.47	240.22
March . .	158.39	158.45	164.63	165.57	173.92	172.73	213.53	210.35	149.54	149.50	132.30	133.13	123.43	123.27	123.27	123.06	218.75	218.75	5.15	4.79	146.81	146.85	239.01	240.34
April . . .	158.09	158.15	166.18	166.12	175.56	175.59	214.59	214.25	149.29	149.33	133.03	134.23	123.47	123.52	123.31	123.32	218.63	218.76	5.93	5.81	146.61	146.63	239.04	240.17
May . . .	157.96	158.64	166.57	166.59	175.56	175.30	214.54	214.50	149.60	149.32	133.82	133.56	123.79	123.47	123.45	123.02	218.49	218.71	6.44	6.71	146.55	146.52	239.00	240.00
June . . .	158.80	159.36	167.18	165.36	175.45	175.37	214.71	214.84	149.59	149.17	133.56	132.68	123.79	123.70	123.61	123.47	218.36	218.71	6.55	6.58	146.43	146.57	239.48	240.10
July . . .	159.09	157.57	162.37	162.79	175.17	175.30	213.90	214.07	149.15	148.96	131.99	131.44	123.81	123.76	123.58	123.50	218.65	218.83	5.73	5.62	146.69	146.90	239.89	240.60
August . .	158.67	157.77	160.86	158.86	174.21	175.00	208.51	208.92	148.85	148.83	130.34	130.04	123.82	123.86	123.59	123.58	218.90	218.90	3.82	3.67	146.82	146.93	239.67	240.46
September,	157.63	157.88	164.02	160.47	175.14	173.17	202.33	204.72	149.07	148.94	129.55	129.02	123.77	123.69	123.54	123.43	218.76	218.67	3.31	2.29	146.70	146.84	239.59	240.35
October . .	157.99	157.44	165.85	158.51	175.62	169.84	205.15	203.35	149.54	148.81	130.38	127.67	123.86	123.69	123.53	123.43	218.96	218.69	4.68	0.20	146.58	146.56	240.05	240.61
November .	157.92	156.97	166.13	158.64	175.52	164.60	212.53	204.41	149.19	148.75	132.47	126.71	123.88	123.82	123.68	123.31	218.89	218.60	5.65	— 0.30	146.61	146.90	240.39	240.73
December .	157.84	157.00	166.09	162.15	175.47	164.03	214.13	206.51	149.26	148.84	132.64	126.72	123.53	123.73	123.03	123.51	218.74	218.91	5.48	0.68	146.70	146.84	239.82	240.62
Yearly averages	158.19	157.98	165.18	163.11	175.23	172.34	211.92	209.99	149.33	149.12	132.08	130.91	123.67	123.62	123.40	123.34	218.69	218.76	5.31	3.78	146.67	146.78	239.55	240.36

Statement of Operations at the Chestnut-Hill Pumping-Station for 1891.

1891.	Engine No. 1.			Engine No. 2.			Total amount pumped.	Daily average amount pumped.	Total amount of coal consumed.	Daily average amount of coal consumed.	Total ashes and clinkers.	Per cent. ashes and clinkers.	Quantity pumped per lb. of coal. No correction for heating and lighting.	Quantity pumped per lb. of coal. Corrected for heating and lighting.	Average lift in feet.	Duty in ft.-lbs. per 100 lbs. of coal.			Water evaporated in boiler per lb. of coal.	
	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.										Without correction for heating and lighting	Corrected for heating buildings.	Corrected for heating and lighting.	Actual.	From and at 212°.
Month.	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Lbs.*	*Lbs.*	*Lbs.*	*Per Cent.*	*Gallons.*	*Gallons.*	*Feet.*	*Ft.-lbs.*	*Ft.-lbs.*	*Ft.-lbs.*	*Lbs.*	*Lbs.*
Jan.	. .	.	. . . . .	596	15	209,531,125	209,531,125	6,759,100	245,844	7,930	21,504	8.7	852.3	957.1	123.66	87,899,100	93,436,700	98,669,200	10.26	12.10
Feb.	533	00	188,962,250	. .	.	. . . . .	188,962,250	6,748,700	216,763	7,742	18,568	8.6	871.7	975.4	124.05	90,188,900	95,780,600	100,952,800	10.28	12.11
March	. .	.	. . . . .	579	00	205,505,850	205,505,850	6,629,200	235,933	7,611	20,706	8.8	871.0	964.2	124.72	90,602,000	95,494,500	100,269,200	10.17	11.98
April	559	15	197,856,500	. .	.	. . . . .	197,856,500	6,595,200	220,362	7,345	19,419	8.8	897.9	972.4	124.24	93,033,900	96,383,100	100,720,300	10.26	12.02
May	. .	.	. . . . .	620	00	221,006,625	221,006,625	7,129,200	240,462	7,757	20,988	8.7	919.1	974.2	124.35	95,317,100	97,509,400	101,019,700	10.20	11.88
June	633	00	230,849,300	. .	.	. . . . .	230,849,300	7,695,000	237,339	7,911	19,623	8.3	972.7	1004.8	123.85	100,466,600	. . . . .	103,782,000	10.29	11.92
July	. .	.	. . . . .	629	40	237,948,475	237,948,475	7,675,800	248,657	8,021	19,474	7.8	956.9	986.6	124.72	99,537,000	. . . . .	102,622,600	10.49	12.12
Aug.	617	10	234,275,135	. .	.	. . . . .	234,275,135	7,557,300	241,270	7,783	18,919	7.8	971.0	1009.8	124.55	100,863,200	. . . . .	104,897,700	10.50	12.09
Sept.	495	00	190,820,750	128	15	49,794,525	240,615,275	8,020,500	252,335	8,411	20,965	8.3	953.6	994.6	124.93	99,352,400	. . . . .	103,624,600	10.46	12.07
Oct.	. .	.	. . . . .	619	00	237,324,550	237,324,550	7,655,600	258,957	8,353	22,310	8.6	916.5	974.2	125.32	95,785,900	97,031,100	101,785,600	10.49	12.19
Nov.	582	00	221,711,675	. .	.	. . . . .	221,711,675	7,390,400	246,834	8,228	21,578	8.7	898.2	976.3	125.43	93,961,800	96,780,700	102,103,600	10.40	12.19
Dec.	. .	.	. . . . .	596	15	225,577,650	225,577,650	7,276,700	265,995	8,580	24,517	9.2	848.1	923.6	125.42	88,706,500	91,456,400	96,578,000	10.31	12.15
Totals and averages,	3419	25	1,264,475,610	3768	25	1,386,688,800	2,651,164,410	7,263,500	2,910,751	7,975	248,565	8.5	910.8	975.5	124.60	94,648,900	97,015,100	101,380,800	10.34	12.06

Statement of Operations at the Mystic Pumping-Station for 1891.

1891.	Engine No. 1.			Engine No. 2.			Engine No. 3.			Total amount pumped.	Daily average amount pumped.	Daily average amount of coal consumed.	Daily average amount of ashes and clinkers.	Per cent. ashes and clinkers.	Quantity pumped per pound of coal.	Average lift in feet.	Duty in foot-pounds per 100 pounds of total coal.
	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.	Total pumping-time.		Amount pumped.								
Month.	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Hrs.*	*Min.*	*Gallons.*	*Gallons.*	*Gallons.*	*Lbs.*	*Lbs.*	*Per ct.*	*Gal.*	*Feet.*	*Ft.-lbs.*
January	...	...	.....	201	15	37,659,400	744	00	253,772,800	291,432,200	9,401,000	20,306	2,065	10.2	463.0	147.39	56,908,400
February	...	...	.....	159	00	30,094,300	672	00	235,008,000	265,102,300	9,467,900	19,821	2,026	10.2	477.7	147.17	58,628,100
March	...	...	.....	106	45	21,019,200	733	00	252,339,200	273,358,400	8,818,000	17,968	1,871	10.4	490.8	146.66	60,028,200
April	...	...	.....	...	...	.....	720	00	240,691,200	240,691,200	8,023,000	16,400	1,597	9.7	489.2	146.24	59,666,100
May	29	15	5,390,700	96	00	17,470,700	730	00	251,827,200	274,688,600	8,860,900	18,258	1,836	10.1	485.2	146.99	59,494,700
June	268	45	48,954,200	439	00	92,004,300	443	45	143,001,600	283,960,100	9,465,300	21,750	2,228	10.2	435.2	147.97	53,705,200
July	8	15	1,615,700	237	45	46,643,900	734	15	249,164,800	297,424,400	9,594,300	20,097	2,120	10.6	477.4	148.30	59,046,700
August	19	30	3,790,100	155	30	29,173,200	744	00	249,625,600	282,588,900	9,115,800	18,581	1,924	10.4	490.6	148.42	60,728,300
September	168	45	30,592,600	62	00	12,517,900	692	30	230,604,800	273,715,300	9,123,800	19,133	2,007	10.5	476.9	148.56	59,082,000
October	289	30	54,843,200	41	45	8,471,100	676	30	224,153,600	287,467,900	9,273,200	20,129	2,084	10.4	460.7	149.47	57,428,100
November	...	...	.....	131	30	24,190,200	720	00	232,524,800	256,715,000	8,557,200	18,067	1,863	10.3	473.6	149.81	59,177,800
December	...	...	.....	146	45	27,617,900	742	30	250,188,800	277,806,700	8,961,500	19,274	1,900	9.9	464.9	149.27	57,882,000
Totals and averages	884	00	145,186,500	1,777	15	346,862,100	8,352	30	2,812,902,400	3,304,951,000	9,054,700	19,147	1,960	10.2	472.9	148.02	58,380,500

Rainfall in Inches and Hundredths on the Sudbury River Water-shed for the Year 1891.

1891.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	. . .	0.340	. . .	. . .	. . .	. . .	. . .	0.130	. . .	. . .	. . .	. . .
2	1.425	. . .	. . .	. . .	. . .	0.385	. . .	. . .	. . .	. . .	. . .	. . .
3	. . .	0.545	. . .	2.480	0.100	. . .	. . .	. . .	. . .	. . .	. .	. . .
4	. . .	. . .	2.065	0.010	. . .	0.500	0.225	. . .	. . .	. . .	. . .	0.565
5	0.105	. . .	. .	. . .	. . .	. . .	. . .	. . .	. . .	0.115	. . .	. . .
6	. . .	0.155	. . .	. . .	. . .	. . .	. . .	0.345	2.040	. . .	. . .	. . .
7	. . .	. . .	. . .	. . .	. . .	. . .	0.715	0.070	. . .	0.020	. . .	0.415
8	. . .	0.650	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1.695	. . .	. . .
9	. . .	. . .	1.455	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
10	. . .	0.770	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
11	. . .	. . .	. . .	0.480	. . .	. . .	. . .	. . .	. . .	0.065	0.320	. . .
12	1.130	. . .	. . .	. . .	0.070	. . .	. . .	0.525	. . .	. . .	. . .	. . .
13	. . .	. . .	0.900	. . .	. . .	. . .	. . .	. . .	0.190	0.495	. . .	. . .
14	0.035	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
15	. . .	. . .	. . .	0.635	. . .	. . .	0.020	0.730	0.070	0.020	. . .	0.475
16	. . .	0.070	. . .	. . .	1.160	. . .	. . .	. . .	. . .	. . .	. . .	. . .
17	. . .	0.120	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.830	. . .
18	1.875	0.550	. . .	0.160	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
19	. . .	. . .	0.110	. . .	. . .	1.195	0.355	. . .	. . .	. . .	. . .	. . .
20	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.770	. . .	. . .
21	. . .	0.750	1.945	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
22	1.295	. . .	. . .	. . .	0.030	1.675	. . .	0.810	. . .	. . .	. . .	. . .
23	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.110	. . .	0.575	0.500	0.380
24	. . .	. . .	. . .	. . .	. . .	. . .	0.655	. . .	. . .	. . .	. . .	0.640
25	0.725	. . .	. . .	0.140	. . .	. . .	. . .	0.010	. . .	. . .	. . .	. . .
26	. . .	1.185	. . .	. . .	0.100	. . .	. . .	. . .	. . .	. . .	. . .	0.330
27	0.040	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.085	1.400	. . .
28	. . .	0.100	. . .	. . .	. . .	. . .	. . .	1.645	. . .	. . .	0.040	. . .
29	0.390	. . .	. . .	. . .	0.550	. . .	0.785	. . .	0.080	. . .	. . .	. . .
30	. . .	. . .	. . .	. . .	. . .	0.015	. . .	0.285	. . .	. . .	. . .	0.880
31	. . .	. . .	. . .	. . .	. . .	. . .	0.640	0.065	. . .	. . .	. . .	. . .
Totals. .	7.020	5.235	6.475	3.905	2.010	3.770	3.395	4.725	2.380	3.830	3.090	3.685

Total rainfall during the year, 49.520 inches, being an average of two gauges, located at Framingham and Ashland.

Rainfall in Inches and Hundredths at Lake Cochituate for the Year 1891.

1891.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	...	0.34	...	...	...	...	...	0.12	...	...	...	...
2	1.33	...	...	...	...	0.53	...	...	...	...	...	...
3	...	0.42	...	2.40	0.12	...	...	...	...	...	...	...
4	...	...	1.63	...	...	0.33	0.18	...	...	...	...	0.38
5	0.21	...	...	...	...	...	...	...	...	0.35	...	...
6	...	0.13	...	...	...	...	...	0.49	1.77	...	...	...
7	...	...	...	...	...	...	0.64	0.01	...	...	...	0.22
8	...	0.70	...	...	...	...	...	...	...	1.78	...	...
9	...	...	1.26	...	...	...	...	...	...	...	...	...
10	...	0.80	...	...	...	...	...	...	...	...	...	...
11	...	...	...	0.39	...	...	...	...	...	0.07	0.31	...
12	1.01	...	...	...	0.06	...	...	0.77	...	...	...	...
13	...	...	0.76	...	...	...	...	...	0.23	0.53	...	...
14	0.03	...	...	...	...	...	...	...	...	...	...	...
15	...	...	...	0.60	...	...	0.03	0.61	0.04	0.03	...	0.54
16	...	0.03	...	...	0.82	...	...	...	...	...	...	...
17	...	...	...	...	...	...	...	...	...	...	0.81	...
18	2.00	0.59	...	0.16	0.01	...	...	...	...	...	...	...
19	...	...	0.08	...	...	1.02	0.34	...	...	...	...	...
20	...	...	...	...	...	...	...	...	...	0.65	...	...
21	...	0.71	...	...	...	...	...	...	...	...	...	...
22	1.05	...	1.76	...	...	1.87	...	0.76	...	...	...	...
23	...	...	...	...	...	...	...	0.03	...	0.60	0.37	0.32
24	...	...	...	...	...	...	0.68	...	...	...	...	...
25	0.67	...	...	0.07	...	...	...	...	...	...	...	...
26	...	1.17	...	...	0.15	...	...	...	...	...	...	0.91
27	0.02	...	...	...	...	...	...	...	...	0.11	1.33	...
28	...	0.13	...	...	...	...	...	1.83	0.08	...	0.02	...
29	0.35	...	...	...	...	0.03	0.58	...	...	...	...	...
30	...	...	...	...	0.51	...	...	...	...	...	...	0.80
31	...	...	...	...	...	...	0.54	0.29	...	...	...	...
Totals	6.67	5.02	5.49	3.62	1.67	3.78	2.99	4.91	2.12	4.14	2.84	3.17

Total rainfall during the year, 46.42 inches.

Rainfall in Inches and Hundredths on the Mystic Lake Water-shed for the Year 1891.

1891.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	. . .	0.540	. . .	. . .	. . .	. . .	. . .	0.025	. . .	. . .	. . .	. . .
2	1.130	. . .	. . .	. . .	. . .	0.305	. . .	. . .	. . .	. . .	. . .	. . .
3	. . .	0.480	. . .	2.135	0.120	0.395	0.005	. . .	. . .	. . .	. . .	. . .
4	. . .	. . .	1.920	. . .	. . .	0.015	0.185	. . .	. . .	. . .	. . .	0.365
5	0.145	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.195	. . .	. . .
6	. . .	0.215	. . .	. . .	. . .	. . .	. . .	0.585	1.825	. . .	0.005	. . .
7	. . .	. . .	. . .	. . .	0.020	. . .	0.710	0.130	. . .	. . .	. . .	0.260
8	. . .	0.680	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1.595	. . .	. . .
9	. . .	. . .	0.905	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
10	. . .	0.785	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
11	. . .	. . .	. . .	0.285	. . .	. . .	. . .	. . .	. . .	0.035	0.380	. . .
12	1.035	. . .	. . .	. . .	. . .	. . .	. . .	0.025	. . .	. . .	. . .	. . .
13	. . .	. . .	0.880	. . .	0.045	. . .	. . .	. . .	0.225	. . .	. . .	. . .
14	0.020	. . .	. .	. . .	. . .	. . .	. . .	. . .	. . .	1.155	. . .	. . .
15	. . .	. . .	. . .	0.495	. . .	. . .	0.035	0.750	. . .	0.050	. . .	0.575
16	. . .	. . .	. . .	. . .	1.445	. . .	. . .	. . .	. . .	. . .	. . .	. . .
17	. . .	0.445	. . .	. . .	. . .	. . .	. . .	. . .	0.015	. . .	0.520	. . .
18	1.475	. . .	. . .	0.145	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
19	. . .	. . .	0.105	. . .	. . .	1.540	0.325	. . .	. . .	. . .	. . .	. . .
20	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	1.075	. . .	. . .
21	. . .	0.740	2.230	. . .	. . .	. . .	. . .	. . .	0.015	. . .	. . .	. . .
22	1.030	. . .	. . .	. . .	0.115	2.155	. . .	0.530	. . .	. . .	. . .	. . .
23	. . .	. . .	0.030	. . .	. . .	. . .	. . .	. . .	. . .	0.460	0.265	0.380
24	. . .	. . .	. . .	. . .	. . .	. . .	0.410	0.010	. . .	. . .	. . .	0.540
25	1.010	0.010	. . .	0.090	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
26	. . .	1.060	. . .	. . .	0.075	. . .	. . .	. . .	. . .	. . .	. . .	0.350
27	0.030	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.170	1.405	. . .
28	. . .	0.120	. . .	. . .	. . .	0.010	. . .	1.470	. . .	. . .	0.030	. . .
29	0.370	. . .	. . .	. . .	0.630	0.010	0.655	. . .	0.080	. . .	. . .	. . .
30	. . .	. . .	. . .	. . .	. . .	. . .	0.855	. . .	. . .	. . .	. . .	0.940
31	. . .	. . .	. . .	. . .	0.010	. . .	. . .	0.355	. . .	. . .	. . .	. . .
Totals . .	6.245	5.075	6.070	3.150	2.460	4.430	3.180	3.880	2.160	4.735	2.605	3.410

Total rainfall during the year, 47.400 inches, being an average of two gauges, located at Mystic Lake and Winchester.

Monthly Rainfall in Inches, during 1891, at Various Places in Eastern Massachusetts.

PLACE.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lake Cochituate	6.67	5.02	5.49	3.62	1.67	3.78	2.99	4.91	2.12	4.14	2.84	3.17	46.42
Framingham	6.92	5.12	6.63	3.76	2.17	3.37	3.07	5.22	2.35	3.70	3.04	3.76	49.11
Dam 4, Ashland	7.12	5.35	6.32	4.05	1.85	4.17	3.72	4.23	2.41	3.96	3.14	3.61	49.93
Chestnut Hill	6.93	5.34	5.63	2.98	2.05	4.04	3.44	4.04	3.05	5.70	2.70	3.73	49.63
Mystic Station, Winchester	6.20	5.17	5.95	2.80	2.37	4.33	3.20	3.66	2.01	4.53	2.43	3.20	45.85
Mystic Lake	6.29	4.98	6.19	3.50	2.55	4.53	3.16	4.10	2.31	4.94	2.78	3.62	48.95
Mystic Pumping-station	5.99	4.85	5.68	2.85	2.31	4.09	3.29	3.72	2.67	5.05	2.50	3.45	46.45
Boston Pipe-yard	6.11	5.27	5.35	2.53	2.69	2.86	3.18	3.74	1.58	5.50	2.65	3.66	45.12
Cambridge Observatory	6.09	4.56	4.90	2.44	2.10	3.57	2.93	3.21	2.63	4.82	2.22	3.29	42.76
Waltham, Boston Manufacturing Co.	5.71	4.83	5.96	3.14	1.93	4.02	2.83	5.32	2.53	4.34	2.67	3.90	47.18
Lowell, Locks and Canals Co.	7.041	4.841	6.004	3.564	2.289	3.659	3.169	2.144	1.787	2.926	1.918	3.204	42.546
Lowell, Merrimac Manufacturing Co.	6.62	2.631	4.202	2.80	1.96	3.20	2.62	1.885	1.295	2.60	0.93	3.09	33.833
Average of twelve places	6.474	4.830	5.692	3.169	2.162	3.802	3.133	3.848	2.228	4.351	2.485	3.474	45.648

Rainfall Received and Collected 1891.

MONTH.	SUDBURY.			COCHITUATE.			MYSTIC.		
	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.	Rainfall.	Rainfall collected.	Per cent. collected.
	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.	Inches.	Inches.	Per cent.
January . .	7.020	5.383	76.69	6.67	6.26	93.81	6.245	6.286	100.67
February .	5.235	5.616	107.28	5.02	6.62	131.93	5.075	5.969	117.61
March . . .	6.475	7.944	122.69	5.49	8.03	146.26	6.070	7.208	118.74
April . . .	3.905	4.138	105.97	3.62	4.31	119.15	3.150	3.434	109.01
May	2.010	1.039	51.70	1.67	0.88	52.75	2.460	1.402	57.01
June . . .	3.770	0.714	18.92	3.78	0.77	20.36	4.430	1.010	22.80
July	3.395	0.266	7.83	2.99	0.50	16.65	3.180	0.422	13.27
August . .	4.725	0.290	6.15	4.91	0.72	14.69	3.880	0.439	11.31
September .	2.380	0.350	14.71	2.12	0.76	35.91	2.160	0.417	19.32
October . .	3.830	0.375	9.78	4.14	0.79	18.95	4.735	0.575	12.14
November .	3.090	0.526	17.03	2.84	0.83	29.21	2.605	0.565	21.68
December .	3.685	0.971	26.34	3.17	1.60	50.47	3.410	0.873	25.59
Totals and averages	49.520	27.612	55.76	46.42	32.07	69.08	47.400	28.600	60.34

Table showing the Temperature of Air and Water at Various Stations on the Water-Works.

1891.	TEMPERATURE OF AIR.						TEMPERATURE OF WATER.	
	Chestnut-Hill Reservoir.			Framingham.			Brookline Reservoir.	Mystic Engine-House.
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Mean.	Mean.
January	54.0	9.0	29.3	51.0	0.0	28.3	36.3	34.0
February . . .	62.0	2.0	31.5	62.0	-1.0	31.1	36.0	34.1
March	54.0	0.0	33.8	51.0	0.0	32.9	37.1	35.2
April	78.0	24.0	49.5	77.0	24.0	49.0	48.8	48.3
May	88.5	30.0	57.2	85.0	30.0	57.3	57.0	58.1
June	96.0	42.5	65.9	96.0	38.0	65.4	65.1	68.2
July	90.5	51.0	68.6	89.0	46.0	67.5	71.5	70.7
August	90.0	47.5	70.2	94.0	45.0	69.4	73.6	74.5
September . . .	90.0	47.0	67.2	88.0	44.0	65.4	69.7	69.3
October	86.0	23.5	51.0	84.0	26.0	48.6	58.2	59.5
November . . .	66.0	9.5	41.4	66.0	6.0	39.0	44.6	44.7
December . . .	64.0	12.0	39.2	67.0	8.0	37.8	38.2	39.2

C.

IMPROVED SEWERAGE.

The construction of the extension of the Improved Sewerage system has been continued the past year, the amount expended being $192,409.65.

The condition of the appropriation on Feb. 1, 1892, was as follows:

Total appropriations	$5,913,164 93
Total expenditures	5,865,246 41
Unexpended balance Feb. 1, 1892 . .	$47,918 52

The work done during the year was limited by the funds available, and is described briefly as follows:

CITY PROPER, SECTIONS 5 AND 6, EAST SIDE.

These sections extend in Atlantic avenue and Commercial street, from Central wharf to Hanover street, a distance of 3,120 feet. The sewers were completed in August and are now in service; for a distance of 2,716 feet from Central wharf the sewer is of brick, egg-shaped, 2 feet 4 inches × 3 feet 6 inches, with concrete foundations and side walls, and is laid on a grade of 1 foot in 1,500 feet. The remaining 404 feet of sewer is of 15-inch Akron pipe, embedded in and covered by concrete, and is laid on a grade of 1 foot in 200 feet. Tide-gates and sump manholes were built at Hanover and Battery streets, and six common sewers were intercepted at these points. At Clarke street a sump manhole was built and three common sewers were intercepted, and the old outlet in the dock at this point was bulkheaded off. At Clinton street 20 feet of 5 feet × 6 feet wooden sewer in that street were rebuilt, and a 10-inch inlet pipe built into the intercepting sewer.

In addition to the above work, 70 feet of common sewer (2 feet × 3 feet brick) was rebuilt near Hanover street, and 160 feet of old wooden sewer at Clarke street, which leaked badly, was replaced by a 12-inch Akron pipe, built in the old box sewer and surrounded by concrete.

The work on these sections was done by day labor; it was almost entirely tidework, and was unusually difficult; and the obstructions found in the made land, through which the sewer was built, increased the difficulty and expense of the work. More than 350 cubic yards of stone was taken from

old sea-walls found in the trench; while timber, in the shape of wharves, foundations, piles, etc., was encountered in large quantities.

All of the sewers which formerly emptied into the docks along the water-front, in the city proper, are now intercepted.

DORCHESTER.

On August 19 the sum of $58,000, which had been appropriated in 1890 for the settlement of land damages at Squantum and Moon Island, was, by vote of the city government, made available for the purposes of Improved Sewerage construction.

Work was at once begun on Section 8, Dorchester, by day labor, with the force previously employed on Sections 5 and 6 of the east side intercepting sewers, and is now in progress. This section extends, in the valley of the Neponset river, along the northerly line of the location of the Old Colony Railroad, through private land, from Marsh street to Granite avenue, a distance of 1,950 feet. The sewer is of brick, 4 feet 6 inches in diameter, and is laid on an inclination of 1 foot in 2,000 feet. The trench varies in depth from 20 feet to 39 feet, and can be worked to advantage in the winter season.

Section 10, Dorchester, extends in Butler, Adams, and Washington streets, at Dorchester Lower Mills, from Huntoon street to the foot of Baker's court, a distance of 1,600 feet. A contract for building this section was awarded in January, 1891, to A. A. Hall, and the work was completed by him in November last, at a cost of about $41,000. The sewer is laid on a grade of one foot in 2,000 feet; it is of brick, egg-shaped, 3 feet by 4 feet; the excavation was made by tunnelling, with the exception of a short, open cutting on each end; the material was solid rock, conglomerate and slate being found in about equal proportions; the space between the brickwork of the sewer and the surrounding rock was solidly filled with concrete. The average distance from the surface of the ground to the roof of the tunnel was about 25 feet, yet no damage resulted to the buildings fronting on the streets, from the jar or vibration of the ground. At one point a five-story brick building stood within 23 feet of the centre line of the tunnel, with the bottom of its foundation-walls 15 feet above the tunnel roof; the building was not injured. The only damage done during the progress of the work was a slight breakage of glass in the windows of some of the houses in close proximity to the shaft-openings, due directly to the concussion of the air.

Travel on the surface of the street was not seriously interrupted.

No work has been done on Sections 6, 7, 9, and 11, Dorchester, owing to want of appropriation.

OUTFALL SEWER.

Section 3, outfall sewer, was being constructed at the time of the last annual report, under contract, by H. P. Nawn. This section extends for 2,100 feet in the embankment between Squantum and Moon Island. The sewer is of brick, 12 feet wide and 11 feet high. It has an unusually heavy concrete foundation, with side walls of rubble masonry — iron rods passing through the foundation and arch, as described in last year's report. During the past year 1,300 feet of sewer has been built, and there remains 350 feet to be built under Mr. Nawn's contract.

The completion during the coming summer of the remaining 1,920 feet of sewer in the embankment is imperative. The wooden flume, which now conveys the sewage from Squantum to Moon Island, has been in use seven years, and is in a decidedly dangerous condition. Many of the supporting piles are eaten by worms, and much of the woodwork is badly decayed. Great care and constant repairs will be necessary to maintain the flume in working order for another year.

An appropriation of $90,000 will be necessary to complete this sewer which will replace the flume. The work can be done during the coming summer if a beginning is made as soon as the weather permits.

During the past year a total length of intercepting sewer of 5,385 feet has been built.

An appropriation of $355,000 will be required to complete the Improved Sewerage system as proposed. This includes Sections 6, 7, 8, 9, and 11 of the Dorchester Intercepting, the sewer from Squantum to Moon Island, the seawall at Moon Island, and the pumping-station at the East shaft of the Dorchester-Bay tunnel.

SECTION 1, BRIGHTON INTERCEPTING SEWER.

The contractors for building this difficult section of sewer was the National Construction Co., of Boston, who should have been credited with the successful construction of this work in last year's report, but by an error the credit was given to other parties.

D.

[FROM THE CITY ENGINEER'S REPORT TO THE BOARD OF PARK COMMISSIONERS.]

THE PARKWAY. — BACK BAY FENS.

Excavation of Waterway. — At the beginning of the year there remained a small portion of the waterway in Longwood entrance which had not been excavated. This was done early in the season, and this part of the work is now entirely completed. The dredging-plant has been sold to the Water Department.

Roadways and Walks. — Audubon road has been finished to Brookline avenue, and was opened to travel on January 3, 1892.

The roadway and walks on and near Agassiz bridge have been resurfaced, the curbstones reset, and the gutters repaved. This was made necessary by the settlement of the filling in that vicinity.

The Fenway between Huntington and Tremont entrances has been graded, except a small part occupied by piles of loam. The ride on this section has been nearly all surfaced, and the walk next the water has been graded, its gutters built, and a portion of it covered with crushed stone. On March 20, 1891, contracts were made with Cape Ann Granite Co. for furnishing 2.838 lineal feet of curbstone at $1.49 per lineal foot, and with S. & R. J. Lombard for furnishing 110,000 paving-blocks, at $44.90 per thousand. Both of these contracts have been completed.

The stone-crusher has been run continuously since September 2, and a large amount of stone is now on hand for use on the roads and walks during the coming season. The stone for crushing has been purchased as needed, from different parties, at prices varying from 75 to 90 cents per ton.

Filling. — At the Tremont and Longwood entrances all the filling required has been done under a contract with the Boston & Albany R.R. Co., dated September 16, 1890. The work was completed on February 4, 1892, and the total amount of filling deposited was 161,099 cubic yards, at 51 cents per cubic yard.

Agassiz Bridge. — The parapet walls of this bridge have been built, thus completing this structure.

Fen Bridge. — On November 24, 1890, a contract was made with Mr. William H. Ward, of Lowell, for building this bridge, with the exception of the face walls above the water

level. He began work February 20, 1891, and finished on September 29. The face-walls were built by masons in the employ of the Park Department. The entire work was completed on November 17.

This is a masonry arch bridge of 15 feet span and a width of 96 feet. The foundation is of spruce piles capped with 10 × 10 inch spruce caps, which are covered with 4-inch spruce plank, the surface of the plank being at grade —0.5. The abutments are of granite, 12 feet 6 inches high; and the arch is of brick except at the ends, 20 inches thick, with a rise of 4 feet; the ends of the arches, the wing-walls above grade 7.5, and the parapet are all of rustic masonry composed of Roxbury stone, all except the voussoirs laid dry, with the spaces between the stones filled with loam. The parapet is of quarried stones very roughly dressed, while the stones below the parapet are field bowlders laid without any cutting. The cost of the whole structure was $27,669.34.

Stony-brook Bridge. — On June 23, 1891, a contract was made with Sampson, Clark, & Co., of Boston, for building the superstructure of this bridge. Work was begun on July 1, and it is nearly completed. The bridge spans the waterway leading from the outlet of the new channel of Stony brook and supports the main drive and ride of the Fenway. It consists of five arches of 10-feet span each — three over the waterway and two over foot-paths on either side of the waterway. The bridge is 85 feet wide between the parapets. The arches are supported by piers 2 feet square except at the ends of the main piers, where they are 2 feet × 3 feet 6 inches. Below grade 9.5 the piers are supported by a continuous wall 2 feet thick. At the southerly side of the bridge there is at each end a flight of steps leading from the walks next the driveways from Huntington avenue to the walks passing under the bridge, which latter connect with the walks along the borders of the main waterway; by this means a passage is furnished to people on foot to all parts of the Fens without crossing the drive or ride at grade. In connection with these passageways, recesses for seats are built in the abutments of the bridge. On the northerly end of the bridge there is to be an iron foot-bridge, just above the level of the water, to connect the two walks. The face-work of the masonry is of speckled brick, with trimmings of Milford granite. The barrel vaults underneath the bridge are lined with glazed brick of different colors, laid in patterns. On each staircase there is a drinking-fountain, and the walls are piped for lighting the drive, and also the walks under the bridge. The foundations of the bridge were built

in 1887 by the Sewer Department, as a part of the new channel of Stony brook.

The work was done under the direction of this department, from designs furnished by Messrs. F. L. Olmstead & Co., and Walker & Kimball, architects.

Culvert and Retaining-wall at Brookline Avenue. — The culvert under Brookline avenue, connecting Muddy river with the waterway in the Fens, has been extended, and the foundations for a retaining-wall at its end have been built. The culvert is elliptical in section, 9 feet high and 7 feet wide, with side walls of concrete lined with brick and a brick arch 12 inches thick. It is on a pile and timber platform. There is a rectangular manhole at the end, with grooves for stop-plank. The retaining-wall at the end of the culvert is semicircular in plan, and is built of concrete, resting upon a pile foundation to grade 7; above grade 7 the wall is to be of bowlder work of the same character as the face-walls of the Fen bridge. This bowlder work was not included in the contract, and has not yet been built. The contractor for this work was Mr. Wm. H. Ward, of Lowell. His contract was dated June 23, 1891; work was begun on July 1 and finished on January 7, 1892. The cost of the work covered by the contract was $8,042.

Grading of Slopes, Loaming, and Planting. — The slopes between the ride and the water on that part of the Fens between Huntington and Tremont entrances have been graded and covered with loam, except a small portion near Stony-brook bridge. The slopes on the Longwood entrance and on a part of the Tremont entrance have been finished in the same manner.

Miscellaneous. — Fifty additional settees have been purchased and placed along the walks. The regrading of the plantations on Commonwealth avenue, between West Chester park and Beacon street, has been completed, and the section between West Chester park and Charlesgate East has been planted.

The following table, giving the principal items of work completed, has been corrected to date:

		Per cent. of whole.
Channel excavated	1,227,000 sq. ft.	100
Shore completed	26,700 lin. ft.	100
Marsh completed	833,000 sq. ft.	100
Driveway completed	60,000 sq. yds.	68
Walks completed	24,000 "	46
Ride completed	8,000 "	60
Curbstone set	25,946 lin. ft.	75
Gutters paved	13,300 sq. yds.	67

		Per cent. of whole.
Area covered with loam	1,023,000 sq. ft.	75
Area planted	841,500 "	60
Boundary fence	4,047 lin. ft.	26
Drain laid	6,498 "	
Manholes	6	
Catch-basins	77	
Bridges and culverts	6	

A large amount of other work has been partially completed, but cannot be classified.

The usual force engaged upon the care of plantations, roads, walks, etc., has been employed during the year, and the expense of the same has been charged to the appropriation for maintenance.

MUDDY RIVER AND STONY BROOK COVERED CHANNELS.

The former of these remains in bad condition, as was described in the report for 1887. As the town of Brookline contemplates improving the channels of the brooks flowing into Muddy river, so that in time of freshet the discharge of water into the new open channel through the Parkway will come more suddenly than it does at present, in my opinion it is necessary that the covered channel should be repaired and all obstructions removed. The Stony-brook conduit is in good condition, except that the temporary work at the outlet into Charles river has been somewhat damaged by storms. The gate-chamber has been provided with window-frames and sashes, the same having been omitted when it was built.

MUDDY RIVER.

The contracts in force at the date of the last annual report have all been completed, except a small portion on Section C. The buildings on the Downer-street section were removed early in the summer, and on June 23 a contract was made with Richard D. Shanahan for grading this section. The work was completed in December.

The payments under the above five contracts were as follows, the names given being those of the contractors:

Section A. — James Killian	$14,896 24
Section B. — Owen Nawn	6,883 05
Section C. — Edward F. Brigham (contract not finished)	10,503 92
Section D. — H. P. Nawn	87,304 73
Downer-street Section. — Richard D. Shanahan	4,576 33

All of the above contracts included the excavation of the waterway and the upland and the disposal of the excavated material as filling on ground which required it. The material was not sufficient for doing all the filling required, nor was much of it suitable for foundations for roads and walks.

On Oct. 21, 1891, a contract was made with the Boston & Albany Railroad Company for furnishing and depositing all filling required on that portion of the improvement north and west of the waterway between Brookline avenue and the city boundary. The work is now in progress. A contract was made on November 28, with Moulton & O'Mahoney, for doing all the grading required on that portion of the improvement on the south and east of the waterway, extending as far as Perkins street. This work is progressing favorably. Preliminary plans for the bridge on Brookline avenue having been furnished by Messrs. Olmsted & Co., working plans and specifications were prepared, in consultation with this department, by Mr. A. H. French, engineer for the Brookline Park Commissioners. A contract for building this bridge was made on December 30 with John Sheehan, of Lynn, and work is now in progress under the direction of the Brookline Park Commissioners.

Plans are now being prepared for the Tremont and Bellevue street bridges, and proposals for doing the work will shortly be received.

Arrangements having being made in conjunction with the town of Brookline for the transportation of loam from Basin 6 of the Boston Water-Works, a contract was made with James A. Cahill on July 14 for grading a branch railroad from the main line of the Boston & Albany Railroad to the basin; the work was completed in September, at a cost to the city of Boston of $1,750.18; on September 28 a contract was made with the Boston & Albany Railroad Company for laying the track on the above branch railroad, and for transporting the loam to the Parkway; nothing has yet been done for the Boston Park Department under this contract, except the laying of the track.

The drain from the House of the Good Shepherd having been cut off by the removal of the sewer in Downer street, it was extended by a siphon under the waterway, and connected with the sewer in Brookline avenue.

Arnold Arboretum.

At the beginning of 1891, work was in progress on the grading of the road around the north side of Bussey hill and

across the meadow to the Parkway near Centre and Orchard streets, under a contract with Wm. T. Davis. This contract was subsequently amended, so as to include the grading of the road leading from the before-mentioned road to the Parkway near South street. Another contract was made on July 23 for grading a temporary road across the Parkway to Centre street. The work called for by these contracts has been finished. The total amount of material moved under them was 70,035 cubic yards, and the payments were $24,945.51. There remains a small amount of grading to be done where there has been a settlement of the filling across the meadow. On about 1,700 lineal feet of this road — being the portion of the north side of Bussey hill — the catch-basins and drains have been built, the gutters paved, and the roadway ballasted.

On the road leading from the main drive to Walter street, the catch-basins and drains have been built and the gutters paved. The Water Department has laid a 24-inch water-pipe through this road, but the work not having been completed until recently, the road has not been surfaced; it can be done early in the spring.

Franklin Park.

Drives, Rides, and Walks. — Glen-lane wall has been completed, but the delay in doing it caused by the press of other work for the masons has prevented the completion of the surfacing. The section between Blue Hill avenue and the entrance road from Columbia street has been entirely finished, while on the section between the last-mentioned road and the crossing of old Glen road the drains and catch-basins have been built and most of the gutters paved, so that it will require but a short time to complete the work.

The triangular space between Blue Hill avenue, the entrance from Columbia street, and the easterly end of the Greeting has been graded, and the plantations prepared for planting. The circle at the easterly end of the Greeting has been graded. The curbstone has been set, the gutters paved, and the roadway ballasted. Loop road has been finished, and the last section of it was opened to travel on May 24. The walks in the vicinity are nearly finished, and 1,500 lineal feet of granite steps have been purchased for the same. The ride through the Wilderness has been surfaced. Circuit drive is sub-graded from the junction with the road to Columbia street, around the easterly side of the Park to the entrance from Morton street, except a short section across the valley near Canterbury street, were a culvert is to be

built, and a section between Canterbury hill and the pond which requires filling. On about 800 lineal feet of the Circuit drive the gutters have been paved and the roadway ballasted.

The walk from Ellicottdale to the top of Scarboro' hill has been built.

Drainage. — The main drain at the westerly end of the Greeting has been extended so as to drain the swampy ground near by. Drains have been built on the easterly end of the Greeting, on Glen lane, and on Circuit drive.

Ellicottdale. — That portion of this ground where the gardener's cottage formerly stood has been finished.

Schoolmaster Hill. — The masonry work of the arbor and of the shelter has been completed, including an additional drinking-fountain. The wookwork of the arbor for supporting vines has been erected, so that this structure is complete, except paving of the walks.

Ponds. — Work is now in progress on the excavation of the proposed ponds south of Scarboro' hill, the material being used for filling on Circuit drive, and for building a dam between the ponds and Morton street.

Miscellaneous. — A shelter at the carriage-stand at the entrance to the Park opposite Columbia street is in progress of construction. The flock of sheep increased during the year to 168 in number, and in the fall 64 wethers and old ewes were sold for $350.88. The yield of wool was 792 lbs., which was sold for $187.74. In May lamp-posts and lanters with oil lamps were placed along Glen lane by the Lamp Department, and they have since been maintained by that department.

The following table shows the principal items of work completed to date, but it should not be understood as being a complete statement of the work done, as a large amount of labor has been expended on work which cannot be classified:

Driveways completed	76,000 sq. yds.,	or 5 miles.
Walks completed	47,700 "	or $6\frac{3}{4}$ miles.
Ride completed	10,500 "	or $\frac{3}{4}$ of a mile.
Gutters paved	15,100 "	
Curbstone set		6,460 lin ft.
6-in. water-pipe laid		3,000 "
4-in. water-pipe laid		1,150 "
Hydrants		7
Drinking-fountains		8
Bridge		1
Boundary wall		4,468 lin. ft.
2-ft. 9-in. brick drain		706 "

2 ft. × 2 ft. × 6 in. brick drain	180	lin. ft.
2-ft. brick drain	769	"
18-in. pipe drain	3,020	"
15-in. pipe drain	2,895	"
12-in. pipe drain	1,546	"
10-in. pipe drain	1,844	"
8-in. pipe drain	7,914	"
4-in. pipe drain	190	"
4-in. agricultural tile drain	2,100	"
3-in. agricultural tile drain	3,520	"
2-in. agricultural tile drain	26,713	"
1½-in. agricultural tile drain	19,700	"
Total drain	71,097	"
Manholes	41	
Catch-basins and inlets	143	
Open channel for brook	2,300	"
Area of ground graded and planted or seeded	85	acres.
Gateway	1	

800 lineal feet of Circuit drive have been ballasted and covered with crushed stone, while 2,200 lineal feet have been sub-graded and drained.

MARINE PARK.

Filling. — The filling done under the contract with Joseph E. White, dated October 5, 1889, was completed on October 16, 1891. There were deposited 268,450 cubic yards; the amount paid was $163,754.50. The work of filling north of Broadway, under the contract with Perkins & White, dated September 10, 1890, is still in progress, there having been deposited 310,000 cubic yards.

Loam. — On October 12, 1891, a contract was made with Perkins & White for furnishing and placing loam on that portion of the Park south of the south line of Broadway extended. This work is now in progress.

Q-street Bulkhead. — On February 14, 1891, a contract was made with Perkins & White for building a bulkhead on easterly line of Q street, extending northerly 440 feet from East First street, for retaining the filling on the Park. The work was completed in November, at a cost of $4,985.

Castle-island Bridge. — On July 14, 1891, a contract was made with William L. Miller for building a temporary pile-bridge to connect the mainland with Castle island. Work was begun on August 4, and will be completed early the coming season.

Miscellaneous. — Additional toilet accommodations for

men have been provided at the refectory building. One hundred settees have been placed upon the iron pier, and a new boat purchased.

Wood-island Park.

Additional land and flats having been taken for an extension of the Park, thereby rendering necessary a revision of the plan. But little work of construction has been done. A topographical survey of the land taken has been made.

The grounds prepared in 1890 have been planted.

Charlesbank.

Men's Gymnasium. — The grounds and apparatus having been put in thorough repair, the gymnasium was opened for the season on March 30. Beginning on May 19, the gymnasium was opened in the evening until 9.30 o'clock. For this reason 13 electric-arc lights were provided within the grounds. This change has been very popular, the attendance in the evening during the warm weather having been large and very orderly. The nights having become so cool that the evening attendance had largely fallen off, the evening opening was discontinued on November 7. The gymnasium was closed for the season on January 2, 1892. The attendance for the season was 169,591, an average of 707 per day. Of this number there attended after 7 o'clock P.M. 46,548, or an average of 312 per evening.

Experience has shown that further accommodations in the shape of bathing and dressing rooms are very much needed in connection with the gymnasium.

Women's Lavatory Building. — This building was completed early in the season, it having been constructed under the direction of Messrs. Walker & Kimball, architects. It is of two stories, the lower story being devoted to rooms for the boatmen and workmen and a tool-shed. The upper story is occupied as a woman's lavatory and entrance to the women's gymnasium. Toilet accommodations and boxes for depositing clothing are provided, and turnstiles, with a register attached, control the passage to the gymnasium.

Women's Gymnasium and Girls' Playground. — During the spring the gymnastic apparatus furnished by D. A. Sargent, M.D., was put in place, the frames for supporting the same having been erected the previous season. This apparatus consists of the following pieces:

2 balance swings and frames.
2 seesaws, with side-rails.

2 seesaws, plain.
2 single swings.
2 pole ladders.
2 perpendicular ladders.
4 perpendicular ladders, combined.
5 serpentine ladders.
1 horizontal rope-ladder.
2 perpendicular climbing-poles.
4 long inclined poles.
4 short inclined poles.
4 hanging-ropes.
12 swinging-ropes.
1 long inclined rope, with attachments.
1 set of high parallel bars.
1 set of movable parallel bars.
2 sets of horizontal bars, adjustable.
2 sets of flying-rings, with pulley attachments.
2 single trapezes, with pulley attachments.
11 travelling-rings, with attachments.
2 giant strides.
12 pairs chest weights.
1 set of vaulting-bars.
1 set of movable standards for high jumping
98 pairs wooden dumb-bells.
98 pairs wooden Indian clubs.
98 short wands.
25 long wands.
24 iron quoits.
12 iron hoops.
12 jumping-ropes.

A temporary fence was built around the gymnasium to serve as a screen until the trees and shrubs have become grown. Closets for the dumb-bells, wands, etc., also, sixteen dressing-booths were built within the enclosure. Three sand-courts were constructed in the rear of the building. The Girls' Playground consists of a smooth lawn around which runs a cinder track an eighth of a mile in length. A wooden shelter with seats overlooking the playground has been built under the direction of Messrs. Walker & Kimball.

The gymnasium and playground were opened on June 1 and closed on October 31. They have been in the charge of the Massachusetts Emergency and Hygiene Association, which has provided for their superintendence and the instruction of those using the apparatus. The attendance during the season in both the ground and gymnasium was 144,539, of which number 13,010 were admitted to the play-

ground on Sundays, the gymnasium being closed on that day. The average attendance on week days was 1,095.

Brick Walk. — On September 29, a contract was made with Adelard Phaneuf for paving with brick the walk along Charles street. The work was completed on November 17, and there were laid 3,190 square yards of walk, at a cost of $4,822.10.

Miscellaneous. — Fifty additional settees have been purchased, and temporary awnings have been erected over a portion of them.

Charlestown Parks.

On August 11 a small force was set at work on Charlestown Heights grading the grounds, which work is still in progress.

At the playground, on Alford street, the Street Department is dumping ashes for filling, and considerable material has been received from other parties without expense to the city; the buildings have been removed from the Guild property with one exception, and the vats of the old tannery filled with earth.

Miscellaneous.

Various land-surveys and plans have been made during the year, including those of the land taken for the Dorchester Park on Dorchester avenue and Adams street, for the proposed extension of the South Boston Parkway, and for a proposed muster-ground. Estimates have been made of the cost of various improvements under consideration by the department.

E.

[FROM THE CITY ENGINEER'S REPORT TO THE STREET DEPARTMENT.]

MR. H. H. CARTER, *Superintendent of Streets:*

SIR: I herewith submit the following report of the work done under my direction for your department.

Plans and profiles of streets to be paved were made, quantities estimated, and specifications prepared.

The work done is shown in the accompanying tables; the city furnished all material except paving-gravel, and generally the materials were delivered to the contractor from wharves or from city yards. In some cases the paving-blocks were delivered by the city on or in the vicinity of the work. Such of the old materials as the city could use were delivered by the contractor.

It will thus be seen that the prices contained in the tables have no comparative value, since the conditions differed on each street, some being paved, others macadamized or gravelled; also the length of haul for new supplies and for disposing of old material, and the relative quantity of each, was far from uniform.

Under seventeen contracts, 4.35 miles of street were paved at a cost, exclusive of material furnished by the city, of $169,161.02.

The following is a brief summary of the items:

52,744 sq. yds. block paving on gravel furnished were laid at an average cost of $1.155 per sq. yd.

9,294 sq. yds. block paving on a cement concrete base, with pitched joints, were laid at an average cost of $2.727 per sq. yd.

15,189 sq. yds. of asphalt paving were laid; average cost, with cement concrete base, $3.635 per sq. yd.; when the old base was used, the cost was $2.025 per sq. yd.

31,509 linear feet of edgestones were set at an average cost of $0.329 per linear ft.

21,372 sq. yds. sidewalk were relaid at an average cost of $0.836 per sq. yd.

3,079 sq. yds. of flagging cross-walks were laid at an average cost of $1.184 per sq. yd.

The specifications of one contract provided that the city

should furnish the gravel and remove the old materials. The quantities of work done under that contract have been included in the totals of work done in the above statements, but they have not been used in determining the average costs. Counts of paving-blocks used in small areas actually laid are found to be variable. The average of the largest areas where exact number of blocks used is obtainable is about 25 large and about 38 small blocks to the square yard. The cost of blocks, including culling and wharfage, is about five cents per small block, and seven and one-half cents per large block, making the cost for blocks per yard $1.90 in each case. The small blocks came from Quincy, Mass., and were used for suburban streets; they were delivered on the work. The large blocks came mostly from Cape Ann, and were delivered on wharves.

The average cost of block paving on a gravel foundation was $1.15 + $1.90 = $3.05 per sq. yd.

The work was done under somewhat severe specifications, requiring the removal of 13 inches of old material, the grading and rolling the road-bed, and the furnishing of 6 inches of new gravel. The cost of supervision and inspection is not included in the above. Details of the work done are as follows:

A Street, South Boston, from Broadway to First street, was paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was of cobble paving. The old cobbles were hauled to the crusher at Broadway bridge, the surplus earth to L-street extension; the new paving-blocks were hauled from the New York & New England R.R. wharf, and the edgestones and flagging from the Albany-street paving yard.

First Street, from New York & New England R.R. to F street, was paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was generally of gravel, with concrete patches, and one block from E street to F street was paved with cobbles. The old cobbles were hauled to the crusher at Broadway bridge, the surplus earth to the L-street dump. The new granite blocks were hauled from the New York & New England R.R. wharf and from the Bay State wharf, the edgestones and the flagging from the South End yard; the edgestones were delivered to the contractor on the street.

Troy street, from Harrison avenue to Albany street, was paved with granite blocks on a gravel foundation, by James Grant & Co. The old surface was of macadam, and was very hard. The cobble-stones in the gutter were hauled to the Broadway-bridge crusher, the earth and macadam to

East Chester park, between Swett street and New York & New England R.R.; the new granite blocks, and all other new materials furnished by the city, were delivered from the Albany-street yard.

Longwood avenue, from Huntington avenue to Parker street, was paved with granite blocks on a gravel foundation, by James Doherty & Co. The old surface was of macadam; the surplus earth was hauled to Parker street, near Huntington avenue; the cobble-stones from the gutters to the Tremont-street crusher; the Quincy paving-blocks were delivered on the street, and all other materials furnished by the city were hauled from the Albany-street yard.

Austin street, *Charlestown*, from Main street to Rutherford avenue, was paved with granite blocks on a gravel foundation, by John Turner & Co. The old surface was of macadam. The surplus material was the property of the contractor, and the cobble gutter-stones were purchased by him from the city; the granite paving-blocks and the cross-walks were delivered to the contractor on the street, and the other materials came from the Charlestown paving yard, on Medford street.

A short section of the street in front of a church was paved with asphalt by the Barber Asphalt Paving Company.

Fulton street, from Richmond street to Lewis street, was paved with granite blocks on a gravel foundation, by B. F. Nay & Co. The old surface was paved with cobble-stones, which were hauled to the crusher at Broadway bridge; the surplus earth was disposed of by the contractor: the granite paving-blocks and all paving materials were delivered from the North End paving yard, on Commercial street

Columbus avenue, from the railroad bridge to West Chester park, was nearly all resurfaced by the Barber Asphalt Paving Company. The concrete base where defective was patched, and if not found at proper grade was brought to grade, the new concrete furnished being paid for by the cubic yard. A portion of the street was patched by the company at its own expense, under a five-year guarantee given in 1887; a small portion of the old surface was patched. A plan has been prepared and filed with the contract showing the areas under guarantee, and the time of expiration of the same. The old material was wasted and used for filling on Parker street. The new work is to be kept in order by the company for five years under the contract.

Bedford street, from Chauncy to Columbia street, and *Kingston street*, from Summer to Bedford street, were

paved with granite blocks, with pitched joints on a Rosendale cement base, by H. Gore & Co.

The surface was paved, and a portion of the old blocks were used in the new work; the culls were hauled to Scotia street on the Back Bay; the surplus earth was hauled to Parker street; the new granite blocks were hauled from Wales wharf; and the other new material from the Albany-street yard.

Dudley street, from Washington street to Blue Hill avenue, was repaved by James Grant & Co. The old surface was partly of macadam and partly paved with granite block paving. The old blocks of suitable quality were used in repaving, and the culls were delivered to the Bird-street yard; the surplus filling was delivered on Marshfield and Shirley streets; the new Quincy granite blocks and the sidewalk bricks were delivered to the contractor on the street, and the other new material was hauled from the Albany-street yard.

Terrace street, from Tremont to New Heath street, was paved by A. A. Libby & Co. The old surface was of macadam, and the old material was used for surfacing several streets within a radius of one mile from Terrace street. The new Quincy blocks, the edgestones, and the sidewalk bricks were delivered on the street. The new flagging was hauled from the Albany-street yard. The joints of the paving opposite the school-house, next Tremont street, were pitched at an extra expense of seventy-three cents per square yard.

Second street, from B street to Granite street, and *Third street*, from A street to Second street, South Boston, were paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was cobble-stone paving, the old stones were hauled to the crusher at Broadway bridge, and the surplus excavation was hauled to the L-street extension. The new granite blocks were hauled from the New York & New England wharf, the sidewalk bricks were delivered on the street, and the flagging was hauled from the Albany-street yard.

Tremont street, from Scollay square to Boylston street, was paved with granite blocks on a Rosendale cement concrete base, by H. Gore & Co. The work was let in two sections, with Temple place as the point of division. The old granite blocks were delivered by the contractor on sundry streets, within one and a half miles' haul, and the surplus earth was the property of the contractor. The new granite blocks were hauled from Burnham's wharf, the paving-bricks were delivered on the street, and the flagging

in part was delivered from the Albany-street yard, and in part delivered on the street. The joints of the new paving were filled with hot screened pebbles and hot paving-pitch.

Second street, from Dorchester to E street, South Boston, was paved with granite blocks on a gravel foundation, by J. Doherty & Co. The old surface was of cobble paving. The old cobbles were delivered on Ninth street, opposite H street; the surplus excavation was delivered on the L-street extension. The new granite blocks were hauled from the Bay State wharf, the paving-bricks were delivered on the street, and the flagging hauled from the Albany-street yard.

Dorchester street, from Dorchester avenue to Ninth street, South Boston, was paved with granite blocks on a gravel foundation, by Collins & Ham. The old surface was partly paved with granite blocks and partly macadamized. The old granite blocks in good condition were used in the new work, and the culls and surplus earth were delivered by the contractor on sundry streets within half a mile, mostly on Washburn street; the old cobble gutter-stones were hauled to the crusher at Broadway bridge; the new paving-blocks were hauled from the Thompson & Baker coal wharf on Ninth street; the paving-bricks were delivered on the street, and the flagging was hauled from the Albany-street yard. The paving in front of the school-house was laid with pitched joints.

Beacon street, from Arlington street to Charles street, was paved from the street-railroad track to the northerly edge-stone with asphalt on a Portland cement concrete base, by the Barber Asphalt Paving Company. The gutters and toothing strip next the railroad track were paved with granite blocks, partly delivered from Burnham's wharf and partly delivered on the street; the surplus excavation was hauled to Scotia street. The remainder of the street between the same points was repaved with the old granite blocks, by J. Doherty & Co. This portion was the narrow strip under the trees, adjoining the Public Garden. The joints in the paving were filled with hot pebbles and pitch.

The accompanying table, showing the length of accepted streets in Boston, the area of roadway in each, and the area of each kind of paving or roadway construction, have been prepared for the use of the Street Department. This table is an entirely new computation from the best obtainable original sources. The measurements have been principally made from careful surveys of the Surveying Department, and when information could not be obtained from original surveys, the streets have been measured. They have also been examined to determine the character of the paving, and as it is impossible to determine

City of Boston, Engineering Department.—Table showing Details of Contract Street Paving, Season of 1891.

	Granite blocks on concrete. Item A.		Granite blocks on gravel. Item B.		Trinidad asphalt on concrete. Item C.		For setting edgestones. Item E.		For laying brick sidewalk. Item F.		For laying crosswalk. Item G.		Extra work. Item H.	Total final estimate.
	Bid.	Final estimate.	Bid.	Final estimate.	Bid.	Final estimate.	Bid.	Final estimate.	Bid.	Final estimate.	Bid.	Final estimate.	Final estimate	
A street			$1 05	2,542 sq. yds.			$0 55	1,362 lin. ft.	$0.91	1,124 sq. yds.	$1 15	175 sq. yds.		
Collins & Ham				$2,669 10				$749 10		$1,022 84		$201 25	$27 60	$4,669 89
First street			1 18	9,400 sq. yds.			0 55	4,434 lin. ft.	0.91	1,897 sq. yds.	1 15	337 sq. yds.		
Collins & Ham				$11,092 00				$2,438 70		$1,726 27		$387 55	491 72	16,136 24
Troy street			1 52	1,952 sq. yds.			0 35	1,009 lin. ft.	1.32	627.5 sq. yds.	1 98	72.5 sq. yds.		
Grant & Co.				$2,967 04				$353 15		$828 30		$143 55	87 40	4,379 44
Longwood avenue			1 22	5,313 sq. yds.			0 15	2,796 lin. ft.	0.66	1,774 sq. yds.	0 27	206 sq. yds.		
J. Doherty & Co.				$6,481 86				$419 40		$1,170 84		$55 62	29 90	8,157 62
Austin street			1 30	1,318 sq. yds.			0 35	1,115 lin. ft.	1 00	700 sq. yds.	1 50	76 sq. yds.		
John Turner & Co.				$1,713 40				$390 25		$700 00		$114 00	34 25	2,951 90
Fulton street			1 03	1,829 sq. yds			0 21	955 lin. ft.	0 63	621 sq. yds.	0 55	14.5 sq. yds.		
B. F. Nay & Co.				$1,883 87				$200 55		$391 23		$7 98	346 15	2,829 78
Columbus avenue					$3 75	1,088½ sq. yds.								
Barber Asphalt Paving Company						$4,081 25								4,081 25
Bedford & Kingston streets	$2 66	2,186⅔ sq. yds.					0 30	629 lin. ft.	0 91	462½ sq. yds.	2 34	134⅚ sq. yds.		
H. Gore & Co.		$5,816 53						$188 70		$420 88		$314 73	231 21	6,972 05
Dudley street	0 95	9,106 sq. yds.					0 28	5,600 lin. ft.	0 79	4,124 sq. yds.	1 42	542 sq. yds.		
James Grant & Co.		$8,650 70						$1,568 00		$3,257 96		$769 64	185 97	14,432 27
Terrace street	1.05	5,995 sq. yds.					0 32½	3,778 lin. ft.	0 75	1,720 sq. yds.	1 30	113 sq. yds.		
Albert A. Libby & Co.		$6,294 75						$1,227 85		$1,290 00		$146 90	584 48	9,543 98
Beacon street	2 00	115.5 sq. yds.			3 60	3,633 sq. yds.					1 05	237.5 sq. yds.		
Barber Asphalt Paving Company		$231 00				$13,078 80						$249 38		13,559 18
Second and Third streets			1 17	3,899 sq. yds.			0 33	1,906 lin. ft.	0 91	1,518 sq. yds.	1 35	122 sq. yds.		
Collins & Ham				$4,561 83				$628 98		$1,381 38		$164 70	245 20	6,982 09
Tremont street — Boylston street to Temple place.	2 76	3,592 sq. yds.	1 19	574 sq. yds.			0 39	791 lin. ft.	0 90	937 sq. yds.	2 74	276 sq. yds.		
H. Gore & Co.		$9,913 92		$683 06				$308 49		$843 30		$717 24	393 29	12,859 30
Tremont street — Temple place to Scollay square.	2 76	3,400 sq. yds.	1 19	1,042 sq. yds.			0 39	1,326 lin. ft.	0 90	1,100 sq. yds.	2 74	394 sq. yds.		
H. Gore & Co.		$9,384 00		$1,239 98				$517 14		$990 00		$1,079 56	591 82	13,802 50
Second street — Dorchester street to E street			1 25	5,022 sq. yds.			0 23	2,651 lin. ft.	0 78	2,128 sq. yds.	1 00	172 sq. yds.		
J. Doherty & Co.				$6,277 50				$609 73		$1,659 84		$172 00	291 35	9,010 42
Dorchester street			1 35	4,752 sq. yds.			0 24	3,157 lin. ft.	0 83	2,639 sq. yds.	1 35	207 sq. yds.		
Collins & Ham				$6,415 20				$757 68		$2,190 37		$279 45	294 63	9,937 33
Average of bids. Total quantities	$2.545	9,294.2 sq. yds.	$1.188	52,744 sq. yds.	$3.675	4,721 sq. yds.	$0.332	31,509 lin. ft.	$0.871	21,372 sq. yds.	$1.173	3,079 sq. yds.		
Average by final estimate. Total cost	$2.727	$25,345 45	$1.155	$60,930 29	$3.635	$17,160 05	$0.329	$10,357 72	$0.836	$17,873 21	$1.184	$4,803 55	$3,834 97	$140,305 24
														28,855 78
														$169,161 02

Note.—The average for crosswalks do not include those in Bedford and Kingston streets and Tremont street.
Thirty-nine dollars was deducted from Item "G" on Tremont street (Boylston to Temple place), as per final estimate.
Also the following quantities were not included in the above table, on account of their not coming under the regular items; but they are included in total cost of all work, as per table.

Beacon street, J. Doherty:	596⅔ sq. yds. granite blocks on gravel, at $1.37	$817 55	
	104½ " " " " " " " $0.65	67 92	
	137⅓ lin. ft. setting edgestones, at $0.15	20 60	
	1,045 sq. yds. laying brick sidewalk, at $0.40	418 00	
			$1,324 07
Columbus avenue.	10,468 sq. yds. asphalt on old concrete, at $2.25	$23,553 00	
	475 1-7 cu. yds. Portland concrete, at $8.50	4,038 71	
		$27,591 71	
	30 loads old asphalt bought from city	60 00	
			27,531 71
			$28,855 78

Table showing Lengths and Areas of Paving on Accepted Streets.

This is a new table made from official plans and actual surveys, and not compiled from previous reports. Correct to Feb. 1, 1892.

	Length in Miles.								Area in Pavement in Square Yards.							
	Asphalt.	Block.	Brick.	Cobble.	Macadam.	Gravel.	Not Graded.	Totals.	Asphalt.	Block.	Brick.	Cobble.	Macadam.	Gravel.	Not Graded.	Totals.
Year 1891 Report	3.2	64.9	. . . .	6.5	174.6	160.9	. . . .	409.7	54,070	1,429,620	. . .	109,890				
City Proper, Feb. 1, 1892 .	*4.07	39.67	0.36	4.41	31.33	0.78	0.07	80.69	65,655	860,853	3,638	52,156	606,675	13,207	1,204	1,603,388
Charlestown " .	0.03	7.68	. . . .	0.29	14.46	0.03	0.05	22.54	421	178,060	. . .	2,936	219,471	161	762	401,811
East Boston " .	. . . .	3.50	. . . .	0.48	2.09	20.30	0.18	26.55	. . . .	83,286	. . .	9,621	39,536	389,142	3,555	525,140
South Boston " .	0.33	10.24	. . . .	0.75	23.33	1.82	5.71	42.18	4,271	218,076	. . .	14,959	405,661	38,173	118,371	799,511
Roxbury " .	0.23	6.38	. . . .	0.01	52.24	16.06	0.70	75.62	3,559	139,776	. . .	717	932,270	263,319	9,530	1,349,171
West Roxbury " .	. . . .	0.09	. . . .	. . . .	24.67	47.29	0.67	72.72	. . . .	2,067	. . .	. . . .	433,826	739,700	10,492	1,186,085
Dorchester " .	. . . .	1.73	. . . .	. . . .	40.01	36.59	1.47	79.80	. . . .	39,444	. . .	. . . .	718,302	613,177	31,050	1,401,973
Brighton " .	. . . .	. . . .	. . . .	. . . .	16.43	16.61	1.45	34.49	. . . .	. . . . .	. . .	. . . .	399,365	254,749	26,977	681,091
Total	4.66	69.29	0.36	5.94	204.56	139.48	10.30	434.59	73,906	1,521,562	3,638	80,389	3,755,106	2,311,628	201,941	7,948,170

Total Public Streets, 434.59 miles.

NOTE.—In the above table the City is sub-divided on the original boundary-lines between the districts.

* Of this amount, 0.48 miles, or 8,501 square yards, Asphalt Blocks.

at this season of the year whether a street is macadamized or simply gravelled, the table has been checked by the district foreman and by the Deputy Superintendent of Streets. In giving lengths and areas, care has been taken to include intersections of streets but once, and the detail table shows the streets from which the intersections have been deducted. The general rule has been to include intersections as part of the principal street.

The engineering force has done considerable work of a miscellaneous character, and numerous estimates for new work have also been made.

BENNINGTON–STREET CULVERT.

Plans and estimates were made for a wooden culvert across Bennington street, between Saratoga street and Wadsworth street.

BERKELEY–STREET BRIDGE, OVER THE B. & A. R.R.

A contract was made with John Cavanagh & Co., dated October 9, 1891, for taking down the parapets and bridge seats of Berkeley-street bridge and rebuilding the same with granite masonry laid solid in cement mortar, of the dimensions required to receive the new bridge. This work is now complete, with the exception of one parapet stone which cannot be placed until the truss used for a temporary support of the telephone wires is removed.

The contract price for the work is $2,290.

An agreement was made with the Boston Bridge Works, October 7, 1891, for removing the old bridge, for the sum of $350. The work called for under this agreement has been completed, with the exception of the sidewalk truss carrying the telephone wires, which was moved sufficiently to allow the new bridge to be placed. As soon as the wires are in place on the bridge, this truss will be removed.

The new superstructure is a through plate girder bridge, consisting of six lines of plate girders, dividing the street into two roadways; two sidewalks and a centre walk is also used for two lines of water-pipes. The bridge is seventy-one feet long and seventy-eight feet six inches wide between centres of sidewalk girders. The four roadway girders have curved upper flanges five feet six inches deep at centres, and four feet six inches deep at ends. The two sidewalk girders are four feet six inches deep, with straight upper flanges, and are to have hand-rails on top. The floor-beams for the roadway are built beams, and for the walks are 9-inch steel I beams.

The roadway and sidewalk stringers are of hard-pine, the roadway flooring-plank is of spruce, the under course being four inches thick and the upper course two inches thick. The sidewalk is planked with 2-inch hard-pine.

The contractor for the ironwork was the Boston Bridge Works, and the contract price was $4,898.

The wooden flooring and the painting of the bridge have been done by the Bridge Division.

Chelsea Bridge, North, Steam-power.

Machinery for moving both the north and south draws of Chelsea bridge by steam-power has been erected and is now ready for use. On the pier of the south draw, there is an engine-house 15×20 feet, in which is placed a double 6×12 inch engine and boiler. An endless chain passes around the turntable drum of the draw, and the power is transmitted from the engine by bevel gearing, a horizontal shaft, and sprocket wheel.

At the north draw an addition 26 × 32 feet has been made to the draw-pier on which the engine-house is placed. This draw is to be moved by means of wire ropes attached to the draw and to a 36-inch drum in the engine-house. A reversing-engine with two 6 × 12 inch cylinders will furnish the power.

At each draw a winch-head has been placed for working vessels through the draw by steam-power.

The machinery has been furnished and set up by Miller & Shaw, and the engine-houses and other woodwork was done by the Bridge Division.

Chelsea Bridge, North, Fender-guard.

Plans and specifications for building a fender-guard 173 feet long at the north draw of Chelsea bridge have been made.

Cornwall-Street Bridge, over Stony-Brook Channel.

A plan and bill of material for a new bridge on Cornwall street were furnished, and the structure has been built by the Bridge Division.

The bridge has a single span, 32 feet long over all, and a total width of 40 feet, divided into a roadway of 26 feet and two sidewalks of 7 feet each. The span consists of 12 lines of trussed beams, each made of two 6 × 12 inch hard-pine sticks, trussed by a $1\frac{1}{8}$-inch diameter rod.

The roadway planking is of spruce, the under course being 4 inches thick and the upper, or sheathing course, being 2 inches thick. The sidewalk is planked with 3-inch planed hard-pine.

The end supports of the bridge are timber bulkheads, each having nine 10 inch × 10 inch hard-pine posts, with a 6 inch × 10 inch hard-pine sill, sunk about 9 feet into the ground, and capped with a 12 inch × 12 inch hard-pine stick.

Hill-Street Retaining-wall.

A contract was made with Donovan & Brock, Boston, dated October 6, 1891, for building a retaining-wall at the easterly end of Hill street, on the line of Sackville street.

The wall is of granite, laid solid in cement mortar, and rests on a concrete foundation. The wall is capped with a granite coping, and has on top a close board fence 5 feet high.

Total amount paid contractor, $1,485.

Irvington-Street and Yarmouth-Street Retaining-walls.

These walls are located one on each side of the Providence Division of the Old Colony Railroad, at the ends of Irvington and Yarmouth streets, the streets being in line with each other.

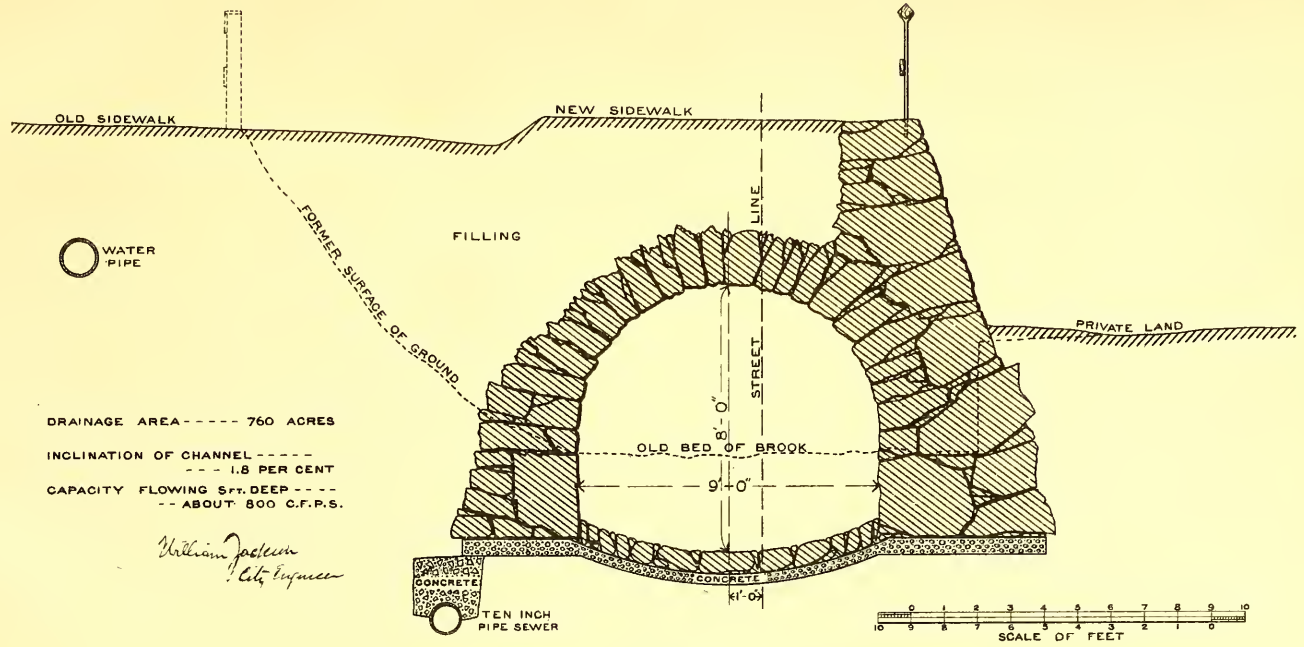
A contract was made with R. D. Shanahan, dated June 15, 1891, for building a retaining-wall at the end of Irvington street, and for adding buttresses to the retaining-wall at the end of Yarmouth street.

The wall is of granite laid solid in cement mortar, and rests upon a pile foundation with concrete cap. Granite buttresses were built at the back of the wall to afford a sufficient foundation for the piers of an iron foot-bridge. At the back of the wall on Yarmouth street, similar buttresses were built of concrete, with granite coping-stones.

The total cost of the work, including the repointing of the wall on Yarmouth street, was $3,537.

Irvington-Street Foot-bridge, over Providence Division, Old Colony Railroad.

An iron foot-bridge has been built over the tracks of the Providence Division of the Old Colony Railroad, on the line of Irvington and Yarmouth streets. The bridge is a through bridge of the riveted bowstring type, resting upon wrought-iron piers. The tops of the piers are on a level with the floor of the bridge, and are reached by stairways from the



STONY BROOK IMPROVEMENT

CROSS SECTION OF NEW CHANNEL AND RETAINING WALL

WASHINGTON STREET : ROSLINDALE

1891

sidewalks of each street. The stairways are of wrought iron with hard-pine treads. The bridge was built by the R. F. Hawkins Iron Works, of Springfield, Mass., under contract dated Sept. 16, 1891, at a total cost of $1,773.

L–Street Abutment.

The contract for building the south abutment of L-street bridge was let to Perkins & White, of Boston, under date of Oct. 28, 1891, for $5,925, and calls for the completion of the work on or before June 15, 1892. At this date the piles have been driven and capped for the foundation, and the larger portion of the ballast and rip-rap placed.

L–Street Bulkhead, South Boston.

Plans and specifications were made in 1890 for extending L-street bulkhead northerly from the bulkhead built in 1889; the length of bulkhead to be built being 727 feet, enclosing 328½ feet of street extension.

The contract for building the bulkhead was awarded to F. G. Whitcomb for $7,200; the work was begun April 23 and completed July 27, 1891, at a total cost of $7,210.

Roxbury–Canal Sea–wall.

Plans and specifications were made for building a sea-wall on Roxbury canal and adjacent dock at the Paving wharf of the Street Department.

No work has yet been done on the wall.

Stony–Brook Improvement.

Roslindale Branches.

This improvement contemplates a channel sufficiently large to carry the rainfall from a tributary water-shed of about 1,000 acres, and will, when this improvement is completed, prevent the flooding in this vicinity during heavy rains; but until the channel has been farther extended up-stream about 300 feet, there will still be danger of occasional floods.

The work done during the past season embraced both the main branch of Stony brook at Roslindale and also a small brook flowing into it. The larger channel extends from a point on the old brook channel about 160 feet below Poplar street, through private land, and in Poplar and Washington streets, a distance of 665 feet. It is partly open and partly covered. The open portion below Poplar street is 12 feet

wide, with side-walls of rubble masonry nowhere less than 6.8 feet high. It is laid on a grade of 1 foot in 100; the covered channel varies in size from 11 feet 6 inches wide × 6 feet 6 inches high to 9 feet wide × 8 feet 6 inches high. Both side-walls and the arch are of rubble masonry; the inclinations are 1 foot in 100 feet and 1 foot in 56 feet; 22 feet of open channel, 9 feet wide, was built at the up-stream end; the bottom is paved throughout with stone or brick, and a concrete foundation extends under both walls and under the paved bottom. The smaller brook channel extends from Birch street through private lands, across Cohasset street, and again through private lands to its junction with the larger channel on the north-west side of Washington street; a total distance of 507 feet. This channel is a stone culvert 4 feet 6 inches high and 5 feet wide; it is laid on an inclination of 1 foot in 125 feet; the side-walls are of rubble with granite covering-stones; the paving is of stone; a concrete foundation extends under the side-walls and under the paved bottom.

Bids for the construction of the work were received July 20, and the contract was awarded to H. P. Nawn, the lowest bidder.

In connection with the brook channels, and during their construction, 340 feet of pipe sewer was built, with the necessary branches, manholes, etc. This sewer was necessary in order to afford drainage to houses on the westerly side of Washington street, which were cut off from the common sewer in that street by the low grade of the new channel; this work was done to much better advantage during the construction of the brook channel than would have been possible after the completion of the work. The sewer is of 10-inch Akron pipe, surrounded by concrete; it is located for a distance of 185 feet immediately outside of the walls of the brook channel, and for the remaining 155 feet, until it enters the common sewer on Washington street, is laid under the new channel, immediately beneath the concrete foundation.

WIDTHS OF DRAW-OPENINGS.

The table showing the widths of draw-openings in the bridges over tide-water in this city is given in Appendix A. The openings have all been remeasured for this report.

WILLIAM JACKSON,
City Engineer.

CITY ENGINEERS.

1850–1892.

E. S. CHESBROUGH, M. Am. Soc. C. E.,
Nov. 18, 1850, to Oct., 1855.[1]

JAMES SLADE,
Oct. 1, 1855, to April 1, 1863.[2]

N. HENRY CRAFTS,
April 1, 1863, to Nov. 25, 1872.

JOSEPH P. DAVIS, M. Am. Soc. C. E.,
Nov. 25, 1872, to March 20, 1880.[3]

HENRY M. WIGHTMAN, M. Am. Soc. C. E.,
April 5, 1880, to April 3, 1885.[4]

WILLIAM JACKSON, M. Am. Soc. C. E.,
April 21, 1885, to present time.

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[1] Died August 18, 1886.
[2] Resigned March 20, 1880.
[3] Died August 25, 1882.
[4] Died April 3, 1885.

APPENDIX A.

Table showing the Widths of Openings for Vessels in all Bridges provided with Draws, in the City of Boston, January, 1892.

Name of Bridges.	Location.	Number of Openings.	Width.	
			Feet.	In.
Boston & Maine R.R.	Boston to Charlestown	1	35	5
" "	Over Miller's River	1	35	9
Broadway	Over Fort-Point Channel	1	43	3
Cambridge st.	Ward 25 to Cambridge	1	36	3
Canal	Boston to East Cambridge	1	35	10
Charles-river	Boston to Charlestown	1	36	0
Chelsea (South Channel)	Charlestown to Chelsea	1	38	10
" (North ")	" " "	1	44	10
Chelsea-st. (East Boston side)	East Boston to Chelsea	2	33	1
" (Chelsea side)	" " "		34	3
Commercial-point	Ward 24	1	24	0
Congress-st. (Boston side)	Over Fort-Point Channel	2	43	3
" (So. Boston side)	" " "		43	11
Dover-st.	" " "	1	36	0
Eastern R.R.	Boston to Charlestown	1	35	10
" "	Over Miller's River	1	35	10
Essex-st.	Ward 25 to Cambridge	1	36	0
Federal st.	Over Fort-Point Channel	1	41	10

Fitchburg R.R.	Boston to Charlestown	1	36	0
" " (for teaming freight)	" " "	1	35	11
Grand Junction R.R.	Ward 25 to Cambridge	1	35	7
" " "	East Boston to Chelsea	1	34	8
Granite	Ward 24 to Milton	1	36	0
Harvard (Boston side)	Boston to Cambridge	2	36	8
" (Cambridge side)	" " "		36	8
Lowell R.R. (freight)	Boston to East Cambridge	1	35	8
" " (passenger)	" " " "	1	35	10
Malden	Charlestown to Everett	1	43	4
Meridian-st. (East Boston side)	East Boston to Chelsea	2	59	2
" (Chelsea side)	" " " "		59	0
Mt. Washington-ave. (Boston side)	Over Fort-Point Channel	2	42	1
" " (So. Boston side)	" " "		42	4
Neponset	Ward 24 to Quincy	1	36	0
New York & New England R.R. (Boston side)	Over Fort-Point Channel	2	40	4
" " " (So. Boston side)	" " "		40	2
" " "	Over South Bay	1	28	4
North Beacon-st.	Ward 25 to Watertown	1	30	2
North Harvard-st.	Ward 25 to Cambridge	1	36	0
Old Colony R.R.	Over Fort-Point Channel	1	36	0
" "	Ward 24 to Quincy	1	36	0
Prison-point	Charlestown to Cambridge	1	36	0
Warren	Boston to Charlestown	1	36	3
West Boston (Boston side)	Boston to Cambridge	2	35	8
" (Cambridge side)	" " "		36	0
Western-ave.	Ward 25 to Cambridge	1	36	0
"	Ward 25 to Watertown	1	30	0

APPENDIX B.

City of Boston, Revised Ordinances, 1892.

CHAPTER 12.

ENGINEERING DEPARTMENT.

SECTION 1. The engineering department shall be under the charge of the city engineer, who shall be consulted on all matters relating to public improvements of every kind where the advice of a civil engineer would be of service; shall, unless otherwise specially provided, take charge of the construction of all public works of the city which properly come under the direction of a civil engineer; shall, except as to sewers, perform all engineering services, and make all examinations and prepare all statements, plans, specifications, and contracts which any department may need in the discharge of its duties; shall, upon being notified by the superintendent of streets, supervise all repairs on the bridges of the city used as highways which affect the safety of the structures, and shall, when required by the mayor or by any officer or board in charge of a department, measure the work done by contract for the city, and certify to the result of such measurement.

SECT. 2. Said engineer shall in his annual report include a report of the safety and completeness of all ponds, basins, and reservoirs under the charge of the water-supply department, and of all bridges within the city limits used as highways.

APPENDIX C.

ENGINEERING DEPARTMENT, PROPERTY SCHEDULE, MAIN OFFICE.

1 horse.
2 carriages.
1 sleigh.
2 harnesses.
3 robes.
Instruments for drawing.
Instruments for surveying, as follows:
2 Temple transits.
5 Buff & Berger transits.
5 Gurley transits.
1 Stackpole transit.
3 Temple levels.
4 Buff & Berger levels.
5 Gurley levels.
11 Boston rods.
4 New York rods.
3 Troy rods.
Cases for plans and books.
Reference Library, 830 vols.
7,945 Plans Engineering Works, loose.
14 vols. Plans Engineering Works, bound.
Photographs of Engineering Works.
Apparatus for blue-printing.
1 microscope.
1 mercurial barometer.
1 aneroid barometer.
1 holosteric barometer.
1 set hydrometers.
1 hygrometer.
1 pr. field-glasses.
2 typewriters.
2 dynamometers.
1 pentagraph.
1 calculating-machine.

IMPROVED SEWERAGE CONSTRUCTION.

SCHEDULE OF PROPERTY IN CHARGE OF ENGINEERING DEPARTMENT, FEBRUARY, 1892.

2 adzes.
2 augers.
14 axes.
11 bars.
3 blocks.
1 blue-print frame.
2 bookcases.
1 Bromley's Atlas, vol. 5.
5 brooms.
9 buildings.
1 buggy.
3 brass scales.
4 calking-irons.
8 chains.
14 chairs.
1 chuck hydrant.
29 covers, manhole.
1 compass beam.
2 cases drawers.
1 derrick, tripod.
5 desks.
10 drills.
1 diaphragm (Edson pump).
2 drawing instruments (sets).
3 drawing-tables.
1 engine, Erie.
10 files.
29 frames, manhole.
1 grindstone.
30 gasolene lamps.
1 harness.
17 hammers.
48 handles.
3 hatchets.
3 hoes.
350 ft. hose, hand.
48 ft. hose, suction.
50 ft. hose, steam.
1 horse.
1,762 ft. iron pipe, 1¼-in.

17 lanterns.
1 level, hand.
4 levels, engineers.
5 levelling-rods.
12 mauls.
3 measuring-rods.
16 mounting-boards.
24 moulds, cement.
3 oil suits.
6 oil cans.
15 pails.
1 plummet lamp.
38 picks.
1 planimeter.
9 plumb-bobs.
2 presses, letter.
1 pump, hand.
1 pump, steam.
paper, drawing.
4 poles, levelling.
21 pipe, suction.
7 rammers.
29 rubber boots.
2 rubber coats.
3 rubber hats.
6 ropes, chain.
7 rods, sighting.
2 sand-heaters.
1 sand screen.
5 saws.
4 scrapers.
49 shovels.
6 tapes, steel.
7 tapes, cloth.
7 stoves.
130 steps, manhole.
1 sleigh.
3 tables.
3 tool-boxes.
4 transits.
1 testing-machine, cement.
6 wheelbarrows.
12 wrenches.

APPENDIX D.

Elevations referred to Boston City Base. (The city base is 0.64 ft. below mean low tide.)

Feet.

0.00 City base.

15.66 Highest tide, April, 1851.

15.33 Coping of dry dock, Charlestown Navy Yard.

12.94 Greatest elevation of high tide per U. S. Tide Table, Nov. 5, 1892 (12.30+0.64)=12.94.

10.44 Mean high water.

8.64 Least elevation of high tide per U. S. Tide Table, 1892 (8.0+0.64)=8.64.

2.84 Greatest elevation of low tide per U. S. Tide Table, Sept. 1, 1892 (2.2+0.64)=2.84.

0.64 Mean low Tide.

—1.96 Lowest elevation of low tide per U. S. Tide Table, April 28, 1892 (—2.6+0.64)= —1.96.

5.00 Piles cut off for building.

9.91 Water-Works base (approx. tide marsh level).

9.82 South Boston base.

[1] —4.98 Cambridge City base.

0.38 South Boston Flats base.

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[1] Cambridge city base is 4.98 ft. below Boston city base.

APPENDIX E.

ENGINEERING DEPARTMENT ANNUAL REPORTS, 1867–1891.

No. of reports.	For the year.	Year published and No. City Document.	No. of reports.	For the year.	Year published and No. City Document.
First	1867	1868 — 22	Fifteenth	1881	1882 — 52
Second and Third	1868–69	1870 — 14	Sixteenth	1882	1883 — 53
Fourth	1870	1871 — 15	Seventeenth	1883	1884 — 55
Fifth and Sixth	1871–72	1873 — 23	Eighteenth	1884	1885 — 54
Seventh	1873	1874 — 20	Nineteenth	1885	1886 — 41
Eighth	1874	1875 — 19	Twentieth	1886	1887 — 38
Ninth	1875	1876 — 24	Twenty-first	1887	1888 — 39
Tenth	1876	1877 — 15	Special report	1888	1888 — 117
Eleventh	1877	1878 — 20	Twenty-second	1888	1889 — 38
Twelfth	1878	1879 — 22	Twenty-third	1889	1890 — 39
Thirteenth	1879	1880 — 33	Twenty-fourth	1890	Executive Department Report, Document 1, Part I. 1891.
Fourteenth	1880	1881 — 25			

CONTENTS ENGINEERING DEPARTMENT REPORTS.

1868–1891,[1] D. R.[2]

[1] The dates given are for the year in which the document was published.
[2] Department Report.

SUBJECT.	Year.	Doc.	Year.
Beacon-street bridge (over B. & A. R.R.)	1886	41	9
" " " " "	1887	38	7
" " " " "	1888	39	7
" " " " "	1888	117	6
" " " " "	1889	38	7
" " " " "	1890	39	7
" " " " "	1891	D.R.	10
Beacon-street bridge (over outlet of B. B. Fens pond; *see, also*, Mill-dam bridge)	1881	25	18
" " " " "	1882	52	8
" " " " "	1883	58	8
" " " " "	1884	55	8
" " " " "	1885	54	8
" " " " "	1886	41	9
" " " " "	1887	38	7
" " " " "	1888	39	6
" " " " "	1888	117	6
" " " " "	1889	38	7
" " " " "	1890	39	7
" " " " "	1891	D.R.	10
Beacon-street widening	1880	33	21
" "	1881	25	19
Beacon-street and Commonwealth-avenue bridges	1882	52	45
Beech-street bridge (over Providence Div., O. C. R.R.)	1878	20	27
" " " " " "	1883	53	19
" " " " " "	1884	55	20
" " " " " "	1885	54	23
" " " " " "	1886	41	20
" " " " " "	1887	38	15
" " " " " "	1888	39	15
Bellevue-avenue bridge (over Prov. Div., O. C. R.R.)	1887	38	15
" " " " " "	1888	39	15
Bennington-street extension	1887	38	16
Berkeley-street bridge (over B. & A. R.R.)	1868	22	23
" " " " "	1870	14	38
" " " " "	1871	15	69
" " " " "	1873	23	47
" " " " "	1874	20	22
" " " " "	1875	19	21
" " " " "	1876	24	14
" " " " "	1877	15	8
" " " " "	1878	20	8
" " " " "	1879	22	8
" " " " "	1880	33	7
" " " " "	1881	25	7
" " " " "	1882	52	10
" " " " "	1883	53	8
" " " " "	1884	55	8
" " " " "	1885	54	8
" " " " "	1886	41	9
" " " " "	1887	38	7
" " " " "	1888	39	7
" " " " "	1888	117	6
" " " " "	1889	38	7
" " " " "	1890	39	7
" " " " "	1891	D.R.	10
Berkeley-street bridge (over Prov. Div., O. C. R.R.)	1870	14	39
" " " " " "	1871	15	70
" " " " " "	1873	23	47

SUBJECT.	Year.	Doc.	Page.
Berkeley-street bridge (over Prov. Div., O. C. R.R.)	1874	20	22
" " " " " "	1875	19	21
" " " " " "	1876	24	14
" " " " " "	1877	15	8
" " " " " "	1878	20	9
" " " " " "	1879	22	8
" " " " " "	1880	33	7
" " " " " "	1881	25	8
" " " " " "	1882	52	10
" " " " " "	1883	53	8
" " " " " "	1884	55	8
" " " " " "	1885	54	9
" " " " " "	1886	41	10
" " " " " "	1887	38	7
" " " " " "	1888	39	7
" " " " " "	1888	117	6
" " " " " "	1889	38	7
" " " " " "	1890	39	8
" " " " " "	1891	D.R.	10
Berkeley-street retaining-walls	1871	15	49
" "	1874	20	37
" "	1877	15	26
Berwick-park retaining-wall	1876	24	35
Blakemore-street bridge (over Prov. Div., O. C. R.R.)	1881	25	22
" " " " " "	1882	52	10, 20
" " " " " "	1883	53	9
" " " " " "	1884	55	8
" " " " " "	1885	54	9
" " " " " "	1886	41	10
" " " " " "	1887	38	7
" " " " " "	1888	39	7
" " " " " "	1888	117	6
" " " " " "	1889	38	8
" " " " " "	1890	39	8
" " " " " "	1891	D.R.	10
B. & A. R.R. bridge (over Park water-way)	1882	52	45
" " " " " "	1883	53	49
Boilers, Chestnut-Hill Pumping-station	1888	39	17
" Highland "	1878	20	31
" Mystic "	1884	55	34
Bolton-street bridge (over N. Y. & N. E. R.R.)	1890	39	8, 22
" " " " "	1891	D.R.	11
Boston Common, asphalt walk	1891	D.R.	25
Bothnia-street bulkhead	1890	39	25
Boundary-wall for the Country Park, P	1890	39	63
" " " "	1891	D.R.	66
Boylston-street bridge (B. B. Fens)	1881	25	41
" " "	1882	52	44
" " "	1883	53	49
" " "	1884	55	8, 50
" " "	1885	54	9, 50
" " "	1886	41	10
" " "	1887	38	7
" " "	1888	39	7
" " "	1888	117	6
" " "	1889	38	8
" " "	1890	39	8
" " "	1891	D.R.	11
Boylston-street bridge (over B. & A. R.R.)	1885	54	50

SUBJECT.	Year.	Doc.	Page.
Bridges supported by railroad corporations:			
Ashmont-street bridge (over O. C. R.R.).....	1884	55	20
Beech-street " (over Prov. Div., O. C. R.R.	1878	20	27
" " " " " " "	1883	53	19
" " " " " " "	1884	55	20
" " " " " " "	1885	54	23
" " " " " " "	1886	41	20
" " " " " " "	1887	38	15
" " " " " " "	1888	39	15
Bellevue-ave. " " " " " "	1887	38	15
" " " " " " "	1888	39	15
Canterbury-st. " " " " " "	1883	53	18
Centre-street " " " " " "	1881	25	17
" " " " " " "	1884	55	20
" " " " " " "	1885	54	23
" " " " " " "	1886	41	20
" " " " " " "	1888	39	15
" and Mt. Vernon-street bridge (over Prov. Div. O. C. R.R.)	1881	25	17
" " " " " " "	1884	55	20
" " " " " " "	1885	54	23
" " " " " " "	1886	41	20
" " " " " " "	1889	38	18
Commercial-street bridge (over O. C. R.R.)..	1881	25	17
" " " " " "	1884	55	20
Cottage Farm " (over B. & A. R.R.)	1885	55	20
Dudley-ave. bridge (over Prov. Div. O.C. R.R.)	1878	20	27
" " " " " "	1886	41	20
" " " " " "	1887	38	15
" " " " " "	1888	39	15
Fourth-street " (over N.Y. & N.E. R.R.) ..	1880	33	18
Harrison-ave. " (over B. & A. R.R.)	1885	54	23
" " " " "	1886	41	20
" " " " "	1887	38	15
" " " " "	1888	39	15
Norfolk-street " (over N.Y. & N. E. R.R.)	1884	55	20
" " " " " "	1885	54	23
" " " " " "	1890	39	14
Park-street " (over Prov. Div. O.C. R.R.)	1888	39	15
Second-street " (over N.Y. & N.E. R.R.)...	1877	15	25
" " " " " " ...	1878	20	27
" " " " " " ...	1880	13	18
Sharon-street " (over Prov. Div. O.C. R.R.)	1878	20	27
Silver-street " (over N.Y. & N.E. R.R.) ...	1878	20	27
Sixth-street " " " " " ...	1877	15	25
Third-street " " " " " ...	1887	15	25
" " " " " " ...	1879	22	28
" " " " " " ...	1880	33	18
Tremont-st. " (over B. & A. R.R.).....	1885	54	23
" " " " "	1886	41	20
" " " " "	1888	38	15
" " " " "	1889	39	18
" " " " "	1890	39	21
Washington-st. bridge (over B. & A. R.R.)....	1885	54	23
" " " " "	1886	41	20
" " " " "	1887	38	15
" " " " "	1888	39	15
" " " " "	1889	38	5, 18
" " " " "	1890	39	21

SUBJECT.	Year.	Doc.	Page.
Brookline-avenue bridge (over B. & A. R.R.)	1888	117	7
" " " " "	1889	38	9
" " " " "	1890	39	9
" " " " "	1891	D.R.	12
Brookline-avenue bridge (over Muddy river)	1874	20	23
" " " " "	1875	19	24
" " " " "	1876	24	20
" " " " "	1877	15	9
" " " " "	1878	20	10
" " " " "	1879	22	9
" " " " "	1880	33	8
" " " " "	1881	25	8
" " " " "	1882	52	11
" " " " "	1883	53	10
" " " " "	1884	55	9
Buildings at Charlesbank	1890	39	66
" " "	1891	D.R.	69
Bulkhead at First and Q streets, So. Boston	1885	54	24
" " Bothnia street	1890	39	25
" " Boylston street	1889	38	21
" " City Point	1887	38	17
" " Cumberland street	1888	39	17
" " Ferdinand "	1884	55	22
" " L "	1890	39	23
" " " "	1891	D.R.	25
" " Lowland "	1888	39	26
Bussey park and Arnold Arboretum, P.	1884	55	52
" " " " "	1885	54	51
" " " " "	1886	41	47
Byron-street bridge (over B., R. B., & L. R.R.)	1890	39	9, 22
" " " " " "	1891	D.R.	12
Cambridge-street bridge (Brighton to Cambridge)	1874	20	32
" " " " "	1875	19	34
" " " " "	1876	24	30
" " " " "	1877	15	21
" " " " "	1878	20	20
" " " " "	1879	22	19
" " " " "	1880	33	12
" " " " "	1881	25	13
" " " " "	1882	52	16
" " " " "	1883	53	15
" " " " "	1884	55	16
" " " " "	1885	54	19
" " " " "	1886	41	16
" " " " "	1887	38	11
" " " " "	1888	39	12
" " " " "	1888	117	12, 18
" " " " "	1889	38	14, 21
" " " " "	1890	39	16
" " " " "	1891	D. R.	18
" " proposed	1887	38	18
Cambridge-street crossing (over B. & A. R. R.)	1882	52	25
Camden-street foot-bridge	1885	54	23
" "	1886	41	20
Canal bridge (Boston to Cambridge)	1873	23	29
" " " " "	1874	20	35, 48
" " " " "	1875	19	38, 50
" " " " "	1876	24	32, 41

SUBJECT.	Year.	Doc.	Page.
Charles-river bridge (Boston to Charlestown)	1879	22	10
" " " "	1880	33	8
" " " "	1881	25	9
" " " "	1882	52	11
" " " "	1883	53	10
" " " "	1884	55	10
" " " "	1885	54	10
" " " "	1886	41	11
" " " "	1887	38	8
" " " "	1888	39	8
" " " "	1888	117	7
" " " "	1889	38	9
" " " "	1890	39	9
" " " "	1891	D.R.	12
Charles-river embankment	1884	55	53
" "	1885	54	52
" "	1886	41	48
" "	1887	38	30
" "	1888	39	36
" "	1889	38	68
" "	1890	39	66
" " work completed	1889	38	61
" dredging	1876	24	38
Charles and Neponset river bridges	1889	38	21
Chelsea bridge (Charlestown to Chelsea)	1874	20	32
" " " "	1875	19	34
" " " "	1876	24	30, 46
" " " "	1877	15	22
" " " "	1878	20	21
" " " "	1879	22	20
" " " "	1880	33	13
Chelsea bridge, North (Mystic River Corporation's wharf to Chelsea)	1881	25	13
" " " " " " "	1882	52	16
" " " " " " "	1883	53	16
" " " " " " "	1884	55	16
" " " " " " "	1885	54	20
" " " " " " "	1886	41	16
" " " " " " "	1887	38	12
" " " " " " "	1888	39	12
" " " " " " "	1888	117	13
" " " " " " "	1889	38	15
" " " " " " "	1890	39	16
" " " " " " "	1891	D.R.	18
Chelsea bridge, South (over South Channel, Mystic river)	1881	25	13
" " " " " " "	1882	52	11
" " " " " " "	1883	53	11
" " " " " " "	1884	55	10
" " " " " " "	1885	54	11
" " " " " " "	1886	41	11
" " " " " " "	1887	38	8
" " " " " " "	1888	39	8
" " " " " " "	1888	117	8
" " " " " " "	1889	38	9
" " " " " " "	1890	39	10
" " " " " " "	1891	D.R.	12
Chelsea-bridge water-pipe box	1888	39	23
Chelsea-st. bridge (East Boston to Chelsea)	1868	22	20

SUBJECT.	Year.	Doc.	Page.
Main Drainage, or Improved Sewerage :			
Section 4½ main sewer	1882	52	38
" 5, " "	1880	33	43
" 5, " "	1881	25	34
" 6, " "	1880	33	43
" 6, " "	1881	25	35
" 1, outfall sewer	1881	25	37
" 1, " "	1882	52	41
" 1, " "	1883	53	43
" 1, " "	1884	55	44
" 1, " "	1885	54	46
" 2, " "	1881	25	37
" 2, " "	1881	52	41
" 2, " "	1883	53	44
" 2, " "	1884	55	45
" 2, " "	1885	54	47
" 3, " "	1891	D.R.	61
" 3, " " and Moon-Island reservoirs	1881	25	39
" 3, " " " "	1882	52	43
" 3, " " " "	1883	53	46
" 3, " " " "	1884	55	46
" 3, " " " "	1885	54	48
outlet " " "	1884	55	47
" 2, South Boston sewer	1884	55	43
" 2, " " "	1885	54	45
" 3, " " "	1880	33	44
" 3, " " intercepting sewer	1881	25	35
" 4, " " sewer	1880	33	44
" 4, " " intercepting sewer	1881	25	35
" 5, " " sewer	1883	53	39
" 5, " " "	1884	55	42
" 6, " " intercepting sewer	1887	38	25
" 6, " " " "	1888	39	26
" 7, " " " "	1891	D.R.	59
" 8, " " " "	1890	39	58
" 8, " " " "	1891	D.R.	59
" 9, " " " "	1890	39	58
" 9, " " " "	1891	D.R.	59
" 2, Stony-brook sewer	1882	52	38
" 2, " intercepting sewer	1881	25	35
" 2, west-side sewer	1882	52	39
" 4, " "	1884	55	42
" 5, " "	1885	54	41
" 6, " "	1885	54	44
" 7, " "	1890	39	57
" 7, " "	1891	D.R.	57
Sewage pumped	1886	41	29
" "	1887	38	23
" "	1888	39	25
Sludge-tank	1886	41	41
Soil-water investigations	1878	20	39
" "	1879	22	40
" "	1886	41	44
Surveying	1878	20	38
Tunnel	1886	41	42
"	1887	38	28
"	1888	39	29
Worthington pumping-engine, sewage	1878	20	31

SUBJECT.	Year.	Doc.	Page.
Newton-street bridge (over Providence Div. O. C. R.R.)	1889	38	12
" " " " " "	1890	39	14
" " " " " "	1891	D.R.	16
Norfolk-street bridges (over N. Y. & N. E. R.R.)	1884	55	20
" " " " " "	1885	54	23
" " " " " "	1890	39	14
Northampton-street district	1875	19	39
" "	1876	24	33
Northern avenue or Oliver-street bridge	1890	39	25
North Beacon-street bridge (Brighton to Watertown)	1874	20	34
" " " " "	1875	19	36
" " " " "	1876	24	31
" " " " "	1877	15	24
" " " " "	1878	20	25
" " " " "	1879	22	22
" " " " "	1880	33	15
" " " " "	1881	25	15
" " " " "	1882	52	18
" " " " "	1883	53	17
" " " " "	1884	55	17
" " " " "	1885	54	21
" " " " "	1886	41	17
" " " " "	1887	38	12
" " " " "	1888	39	13
" " " " "	1888	117	14
" " " " "	1889	38	16
" " " " "	1890	39	18
" " " " "	1891	D.R.	20
Northern and Eastern-avenue sea-walls, etc	1873	23	36
North Harvard-street bridge (Brighton to Cambridge),	1874	20	34
" " " " "	1875	19	36
" " " " "	1876	24	31
" " " " "	1877	15	24
" " " " "	1878	20	24
" " " " "	1879	22	22
" " " " "	1880	33	15
" " " " "	1881	25	15
" " " " "	1882	52	18
" " " " "	1883	53	18
" " " " "	1884	55	18
" " " " "	1885	54	21
" " " " "	1886	41	18
" " " " "	1887	38	13
" " " " "	1888	39	14
" " " " "	1888	117	14, 18
" " " " "	1889	38	16, 21
" " " " "	1890	39	18
" " " " "	1891	D.R.	20
North paving wharf	1888	39	16
" " "	1889	38	38
N. Y. & N. E. R.R., raising grade	1887	15	23
Office and other work, M. D.	1881	25	39
" " " "	1883	53	47
Oliver street or Northern-avenue bridge	1890	39	25
Outlet sewer section, M. D.	1884	55	47
Overlook, Franklin park	1888	39	35
" " "	1889	38	65
" " "	1890	39	65

SUBJECT.	Year.	Doc.	Page.
Schoolmaster Hill, Franklin park	1891	D.R.	66
Sea-walls, Alford street	1881	25	17
" " "	1882	52	20
" Atlantic avenue	1871	15	41
" Condor street	1873	23	35
" Deer Island	1871	15	40
" Northern and Eastern avenues	1873	23	35
" Pinckney street	1873	23	33
" " "	1874	20	38
" pipe-yard, Albany street	1888	39	24
" Roxbury canal	1880	33	19
" " "	1889	38	38
" Swett street	1878	20	29
Seaverns avenue, retaining-wall	1875	19	42
Second-street bridge (over N. Y. & N. E. R.R.)	1877	15	25
" " " " " "	1878	20	27
" " " " " "	1880	33	18
Section 1, Brighton intercepting sewer	1890	39	57
" 1, " " "	1891	D.R.	58
" 3, Dorchester " "	1890	39	59
" 3, " " "	1891	D.R.	60
" 4, " " "	1891	D.R.	60
" 5, " " "	1891	D.R.	60
" 6, " " "	1891	D.R.	60
" 7, " " "	1891	D.R.	60
" 8, " " "	1891	D.R.	60
" 9, " " "	1891	D.R.	60
" 10, " " "	1891	D.R.	60
" 11, " " "	1891	D.R.	60
" 1, East-side sewer, M. D.	1880	33	43
" 2, " " "	1882	52	39
" 2, " " "	1883	53	36
" 3, " " "	1883	53	38
" 4, " " "	1883	53	38
" 5, " " "	1890	39	57
" 5, " " "	1891	D.R.	57
" 6, " " "	1890	39	57
" 6, " " "	1891	D.R.	57
" 4, Main " "	1884	55	39
" 3, " " "	1880	33	42
" 4, " " "	1880	33	42
" 4, " " "	1881	25	34
" 4, " " "	1882	52	38
" 4½, " " "	1880	33	42
" 4½, " " "	1881	25	34
" 4½, " " "	1882	52	38
" 5, " " "	1880	33	43
" 5, " " "	1881	25	34
" 6, " " "	1880	33	43
" 6, " " "	1881	25	35
" 1, Outfall " "	1881	25	37
" 1, " " "	1882	52	41
" 1, " " "	1883	53	43
" 1, " " "	1884	55	44
" 1, " " "	1885	54	46
" 2, " " "	1881	25	37
" 2, " " "	1882	52	41
" 2, " " "	1883	53	44
" 2, " " "	1884	55	45

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Section 2, Outfall sewer M. D.	1885	54	47
" 3, " " "	1891	D.R.	61
" 3, Outfall sewer and Moon-Island reservoirs	1881	25	39
" 3, " " " " "	1882	52	43
" 3, " " " " "	1883	53	46
" 3, " " " " "	1884	55	46
" 3, " " " " "	1885	54	48
Outlet " " " "	1884	55	47
" 2, South Boston sewer, M. D.	1884	55	43
" 2, " " " "	1885	54	45
" 3, " " " "	1880	33	44
" 3, " " intercepting sewer, M. D.	1881	25	35
" 4, " " sewer, M. D.	1880	33	44
" 4, " " intercepting sewer, M. D.	1881	25	35
" 5, " " sewer, M. D.	1883	53	39
" 5, " " " "	1884	55	42
" 6, " " intercepting sewer, M. D.	1887	38	25
" 6, " " " " "	1888	39	26
" 7, " " " " "	1891	D.R.	59
" 8, " " " " "	1890	39	58
" 8, " " " " "	1891	D.R.	59
" 9, " " " " "	1890	39	58
" 9, " " " " "	1891	D.R.	59
" 2, Stony-brook sewer, M. D.	1882	52	38
" 2, " intercepting sewer, M. D.	1881	25	35
" 2, West-side sewer, M. D.	1882	52	39
" 4, " " "	1884	55	42
" 5, " " "	1885	54	41
" 6, " " "	1885	54	54
" 7, " " "	1890	39	57
" 7, " " "	1891	D.R.	57
Sewage pumped, M. D.	1886	41	29
" " "	1887	38	23
" " "	1888	39	25
Sewer at Glover's Corner, Dorchester	1886	41	22
Shallow flowage	1884	55	27
" "	1887	38	18
" " Lake Cochituate	1888	39	18
" " Basins 2–3	1884	55	32
Sharon-street bridge (over Prov. Div. O. C. R.R.)	1878	20	27
Shawmut-avenue bridge (over B. & A. R.R.)	1873	23	22, 48
" " " " "	1874	20	31
" " " " "	1875	19	33
" " " " "	1876	24	29
" " " " "	1877	15	16
" " " " "	1878	20	19
" " " " "	1879	22	17
" " " " "	1880	33	11
" " " " "	1881	25	11
" " " " "	1882	52	15
" " " " "	1883	53	14
" " " " "	1884	55	14
" " " " "	1885	54	16
" " " " "	1886	41	15
" " " " "	1887	38	10
" " " " "	1888	39	11
" " " " "	1887	117	11
" " " " "	1889	38	12
" " " " "	1890	39	14

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Sudbury-river works	1880	33	27, 29
" "	1881	25	27
Suffolk-street district	1871	15	50
" "	1873	23	21
Summer-street survey	1868	22	28
Sumner street, East Boston bridges	1874	20	38
" " foot-bridge	1885	54	29
" " tunnel	1886	41	23
Survey, Adams street	1868	22	29
" Atlantic avenue	1870	14	9
" Brighton	1875	19	12
" Change avenue	1868	22	29
" Devonshire st., between Milk and Water sts.	1868	22	28
" Federal street, between Summer and First sts.	1868	22	27
" Fort Hill	1868	22	26
" High street	1868	22	27
" public building lots	1868	22	13
" Richmond street	1868	22	28
" Roxbury	1868	22	34
" of sewers, M. D.	1889	38	62
" Washington street, between Kneeland and Warren streets	1868	22	29
" West street	1868	22	30
" West Roxbury	1875	19	12
" Williams street	1868	22	28
Surveying, M. D.	1878	20	38
Swett-street bridges (over South-bay sluices)	1876	24	29
" " " " "	1877	15	16
" " " " "	1878	20	19
" " " " "	1879	22	18
" " " " "	1880	33	11
" " " " "	1881	25	11
" " " " "	1882	52	15
" " " " "	1883	53	14
" " " " "	1884	55	14
" " " " "	1885	54	16
" " " " "	1886	41	15
" " " " "	1887	38	11
" " " " "	1888	39	11
" " " " "	1888	117	11
" " " " "	1889	38	13
" " " " "	1890	39	15
" " " " "	1891	D.R.	17
Swett-street extension	1873	23	36
" "	1875	19	40
" "	1876	24	34
" "	1877	15	27
Swett-street sea-wall	1878	20	29
Table showing evaporation at Beacon-hill and Chestnut-hill reservoirs, W. W.	1877	15	35
Table showing widths of draw-openings	1875	19	47
" " " "	1876	24	39
" " " "	1877	15	45
" " " "	1878	20	41
" " " "	1879	22	42
" " " "	1880	33	48
" " " "	1881	25	46

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" " floating scraper in deposit sewers,	1885	54	45
" " Leavitt engines, log of test	1886	41	40
" " manhole cover	1885	54	45
" " Moon-Island reservoir	1883	53	46
" " " "	1884	55	38
" " outlet sewers from Moon-Island reservoir	1884	55	48
" " regulator for sewers	1882	52	38
" " regulating apparatus, Stony-brook intercepting sewer	1881	25	36
" " tank-sewer, sections	1883	53	43
" " tide gate-chamber	1882	52	38
Leyden-street bridge plan (over B., R. B., & L. R.R.)	1890	39	24
Marine park, iron pier, view of one 60-foot span	1889	38	36
Mystic-valley sewer, catch-basin	1879	22	32
" " pipe-crossing at Abbajona river	1879	22	32
" " sewerage works	1889	38	54
" " sectional elevation	1889	38	54
Siphon, thirty-inch, at Warren bridge	1890	39	30
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Oak pile reduced in size by the Limnoria Terebrans	1889	38	40
Spruce piles destroyed by the Limnoria Terebrans	1889	38	40
Spruce pile attacked by the Limnoria Terebrans. The lower part shows the pile uninjured where it was under the mud. No. 1	1889	38	42
Hard-pine timber attacked by the Limnoria. No. 2	1889	38	42
Surface of spruce pile attacked by the Limnoria Terebrans	1889	38	42

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Special Examination of Piling:			
Surface of hard-pine attacked by the Limnoria Terebrans	1889	38	42
Figure 1, Chelura Terebrans; male lateral view, enlarged about 12 diameters	1889	38	43
Figure 2, Limnoria Lignorum; dorsal view enlarged ten diameters	1889	38	40
Warren-bridge draws	1885	54	16
West Chester-park bridge, B. & A. R.R., abutments.	1877	15	20
" " " Prov. Div. O. C. R.R. " .	1877	15	18

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